THE SCIENCE OF WORKS MANAGEMENT

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THE SCIENCE OF WORKS MANAGEMENT

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PREFACE

WORKS management lends itself to so many variations, and refers to the romantic side of business so strongly that learned treatises have been written, and systems have been exploited —under the prevailing idea that manufacturing is little more than a series of operations the invariable sequence of which makes it possible to mark every stage of progress right to the end, and thereby ensure what every capitalist seeks —a profitable investment.

This is so far from being true that, in spite of the assurance that this and that system is sure to produce a profitable result—if the instructions are faithfully adhered to—the end too often leads to red-tape and financial failure, unless it is backed by wise management. Thus, at the outset, human aid is seen to be the essential factor in all good management; because production includes a number of contingent happenings of such variety that must be anticipated and provided for. The pitfalls are so many, and the course so limbered with difficulties that any ideal system, of cast-iron rigidity, must end in ultimate failure.

Most of the vaunted systems can reasonably claim admirable features when used as aids, and not as methods. Their danger, to a profitable end, is due to inflexible ruling that leaves nothing for contingent happenings.

Many men of wide and capable experience in engineering management have felt the lack of some aid, or rather guide, over the rocky way of works management in the pursuit of that will-o'-the-wisp—a profitable ending, at the least cost, without sacrificing excellence. This lack has received attention, and the present purpose is to meet the requirement to the best of the writer's ability. How far success attends the effort must be left to the reader.

With a set of ideal conditions of an invariable character it is possible to institute a system that may be regarded as self-acting, after it has been started successfully, and it is ideally perfect if no further management is needed; but to apply an ideal system to a non-ideal and very variable road of progress is to court failure by attempting the impossible.

Works management may be rightly termed the fly-wheel of the industrial engine, to ensure some regularity to a very irregular set of movements, and the nearer to an ideal movement such management can regulate it, the better its functional success: or works management makes possible the best of probabilities.

There is no question as to the need for a work of this character—being a sort of bridge to span the gap between theory and practice. Our schools and colleges supply the first and our workshops the second; but the connecting link is management—on which rests the success of the ultimate result.

THE AUTHOR.

COVENTRY, *June*, 1914.

CONTENTS

CHAPTER I.

INTRODUCTORY.

MANAGING a works, to many, seems to be a simple matter of seeing that others do things; in fact—mere supervision.

There are not a few who assert that system, pure and simple, is the acme of works management, which includes a sort of perambulatory duty of the manager to be at a given place at a given time, with all the regularity of a clock, so that he is easily found when wanted.

This sort of system is often carried out systematically in works that do not pay a profit. The idea of easily finding the manager seems to be of more importance than paying a dividend. Yet the idea is fallacious and wasteful of money, because a policeman could be as effectual, and cost very much less.

Works management is neither simple nor easy, yet it may include a good system that will, more or less, ensure something like rough regularity. The meaning is that all works management has to deal with a very variable series of productive measures, any one of which may develop a fault at unknown moments, and unless such faults are anticipated the end cannot be satisfactory.

Painting a picture appears to be an easy matter—

only requiring a canvas, a palette, a few brushes and colours, then get to work. Every detail may be of the best, but the object delineated may be a woeful failure if genius is not behind the brush that portrays the object.

The same may be said of works management. The works equipment may be up to date and all of the best, and the finished production may be excellent, but if the cost has swallowed up all profit, as a business transaction it is a failure, because all works are, primarily, run to produce a profit.

Behind the brush must be the genius of the artist, and behind the works management must be the brains of an organizer—the genius of the producer.

Works management assumes a good theoretical knowledge and considerable practical experience; but both are useless as mere qualifications unless special fitness and genius guide the attainments.

This shows the need for a special type of the human element which must include a knowledge of the article to be produced and ensure to it excellence; but it must be provided at the least cost and by the least expenditure of labour.

The genius artist can produce an expression by the mere sweep of the brush, whereas the highly skilled artist, the product of the best art schools, can only attain a similar expression by the laborious process of building up, and may even then fail to produce a result equal to the mere dash of genius.

Works management falls into line with the above examples, showing that the result is with the man and not with the material substances that are dealt with.

The genius artist is born, not educated, to the

pitch of his superb excellence; so is the man who will manage a works successfully. Mere training under high educational advantage may enable the highly skilled to get the expression required, but the cost, compared with the simple flourish of the brush of genius, makes all the difference between wasting time and saving it.

It is impossible to furnish particulars of how every works should be managed—that is to say, in the abstract, because manufactures vary so enormously, from a pin to a steamship; but, fortunately, a set of principles underlies all works organization: besides the cause that produces the effect lies in the brain of the works management. Those responsible for works management need not be specialists of every detail, but they must have a grip of the whole effect, therefore they are the cause of its production.

Thus it is possible to outline works management for some special manufacture, and provide the foundation for the complete organization of any other. It may be the production of soap or the manufacture of steam engines; yet works management means the production of the best at the least cost to ensure a good profit.

All business enterprise is primarily intended to make money, and few would enter the field without some hope of attaining the desired end.

It is true that many enter the lists only to retire discomfited, and perhaps ruined, because so many systems are exploited that guarantee a profit, and only when too late the adopters find that energy, time, and money have been expended uselessly do they begin to comprehend that works manage-

ment, to produce a profit, is not so simple as it looks.

Now, works management really means organizing, and organizing to a profit requires a special kind of genius.

Organizing includes land, buildings, plant, stock, office expenditure, works costs, and commercial outlay, staff salaries, distribution, gas, water, taxes, rates, bad debts, faulty material, mistakes, failures, depreciation, and innumerable items of expenditure —termed indirect expenses.

Besides these are direct expenses, which includes labour, material, and all that pertains to works costs.

As a fact the manufacture of anything from a needle to an anchor entails money outlay, and not until every direct or indirect expense has been met can a profit be declared.

Whatever the articles produced the output is influenced by demand, and this appears to run in cycles; therefore the average output is what the works management must take as a base line.

When a works is running fully employed the indirect or inevitable dead expenses referred to the volume of output, is relatively much less than when the same works only turn out half the full output.

For example, for an indirect expense account of £20,000 under full output conditions the proportion is, say, as 5 is to 10 for the half output.

Taking the outputs as 50 and 100, the proportionate dead expenses are £400 to 1 for the slack time and £200 to 1 for the busy.

These figures are merely arbitrary, because the

variation may not be as much, though it may be more. Between the extremes is the foundation value on which works management must build.

In practice the average of seven years gives reliable results because the time-cycles about cover that time.

Works management or organizing is fitly termed the Fly-Wheel of the business, which stores power under the excess conditions and gives it back during the diminished output, and if correctly proportioned the motion is governed with a regularity that ensures, practically, a reasonable result.

Now, the fly-wheel may be ideal as a separate detail, but unless power is put into its action none can be got out, because a poor storage means a poor output.

With all, apparently, of the best, including up-to-date methods of keeping and tabulating costs, purchasing and producing, the results, from a monetary point of view, may be failure. As a homely illustration, a relatively poor team of horses, which, when expertly driven, may easily beat a superior team if badly handled, may be taken.

Now, driving a team of horses needs careful management, and is therefore a useful example of what successful works management means. The team driver, governed by common sense, will never whip a horse because it sneezes; but he will give way to the chuck caused by the sneeze, and by so doing profits rather than loses, because the forward and downward movement of the head tends to accelerate the speed. This is organizing with flexibility.

With a rigid rein the horse would soon learn to reduce his paces to obtain the freedom needed to meet the contingency, resulting in a slowing down of speed; therefore the difference between expert and inexpert driving is similar to managing a works by a rigid system and organizing the same with some flexibility of method.

This brings in what sounds rather paradoxical, namely, that successful works management allows latitude, and the unsuccessful permits none.

As with the expert driver, when utilizing a relatively poor team, he may easily outdistance a better team handled by a poor driver. The first is prepared for exigency and loses nothing by it, whereas the latter, under the rigid system of control, loses speed and worries his team, and the result is a poor finish.

Works conducted on similar lines produce similar results; therefore the example is an object lesson that can be easily understood.

The roadway of progress for the team includes rises and declivities, curves and bends, and unequal road surface; all of which must be negotiated without disturbing the average speed unnecessarily; and in a similar way the course of production is beset with irregularities which the management must take cognizance of, and provide for.

Under good management the expert manipulator of the horse team gets many advantages from a poor team, whereas he of the rigid rein and splendid team, worries his horses, slackens progress, and gets a poor finish.

It is evident that successful works management

is flexible, not rigid as the laws of the Medes and Persians, and by organizing on flexible lines the best results are reached at the least cost. By such methods it would be sheer folly to spend 6d. in searching for what cost a 1d., which is the method a rigid system entails; therefore it is bad organizing and means wasting money.

Some systems are so elaborated, where provision is made for every detail, that many thoughtless people imagine a works can be run on the system with cheap labour and no management. In many cases mere boys are employed to carry on a system that the best brains have exploited, and then people wonder that the end is a fiasco.

It is just as reasonable to expect a watch to keep good time after lying at the bottom of the Thames for some time, because it was synchronized at Kew Observatory, as to expect mere system and cheap labour to ensure a continual profit.

Whilst true that works management is organizing, it is also true that it includes systematic methods; but it is not adherence to an inflexible law.

As an object lesson of practical utility, easily understood, an hypothetical case of two firms is advanced, both of which are fully equipped and up to date, and whose products are of recognized excellence, because every detail is subjected to expert examination, and is only passed if conforming to the limit standard; yet A firm pays a good dividend, and B loses money.

The quality and price are alike from both firms, and being assumedly installed as neighbours, transit and other facilities are common to both.

A visit to both will reveal the fact that the commercial and general office methods are alike, with all that is up to date, including book-keeping, estimating, costing, buying, selling, and every facility that money can give is provided to gain even the slightest advantage to aid the desired end.

It may be noted that B's staff salaries are lower than A's, although B's staff are more highly educated, some of whom possess high mathematical talents, and many have the advantage of a University training.

A's staff are of a different stamp, full of practical experience but wanting in high educational advantages. Probably none are able to take advantage of the "Calculus," and certainly none seem to pay much heed to many places of decimals. Indeed, they rather scoff at what they term fanciful figuring—where factors of safety of 3 to 6 are used in common practice.

But the offices of the officials show a marked difference. In A's works they look as if they were rarely used, because manager's and foremen's tables are free of papers, except a few rolls of drawings, though the manager's sanctum shows a huge waste-paper basket well filled. A piece of paper picked from the floor is evidently part of a rough sketch, and another is filled with figures but without any apparent order, and no signs of formula. In fact, all the official offices present the appearance of the occupants having an easy time.

B's offices are filled with papers arranged in an orderly manner, and every open spot on the tables is the place for carefully compiled lists of figures, and

much formula; showing that calculations of a very abstruse character have been engaging the attention of its owner. The walls are covered with charts, beautifully and artistically delineated, showing the skill and ability of the staff. Evidently B's staff are not so favourably placed as A's in regard to an easy time, because they certainly have a strenuous time and find plenty to do.

A most careful examination of the methods used in both works in regard to the passing of work showed the standards to be equally good, and both were of a very rigid character, using the same limits, and the class of men employed were of the best—highly trained, intelligent mechanics.

One other important place to note was the testing house, which in both instances was excellent to the point of elaboration.

B firm expressed themselves proudly of their station, which they claimed to be one of the best in the world; yet it was all made from the scrap that failed to pass the examiner's standards.

A firm merely said, Our testing station is one of the best, made of our usual products.

Broadly speaking, there was little to choose between the two firms. The only notable difference was that referred to the respective staffs.

Still there was a difference because A's works possessed a building which they called the "Coroner's Court," and it was this building, or rather its use, that made the difference between profit and loss, good management and bad.

In the Coroner's Court of A's works what was termed an inquest was held on all material the

examiners refused to pass. The Jury comprised Foremen and Manager, and in the course of their examination the ripe experience told when one pointed to a blemish in a large crank-shaft, and declared that such a shaft with a similar blemish had been at work for years, and was running to-day as good as ever. That Coroner's inquest resulted in saving £1000 of material from the scrap. The rigid rein of system was relaxed and good organizing resulted in the saving of £1000.

Experience saved the situation, and ensured a profit.

Though the two examples are merely imaginary their counterparts are easily found in the manufacturing world, but the examples serve the purpose of pointing a lesson, that every fault should be revealed, but not every fault should make a scrap article.

On some such lines profits are made or lost, and experienced works management may be able to save the loss and gain the profit.

Enough has been said by way of introduction to lay off a set of principles which can form the base from which successful works management may be demonstrated.

In a certain sense much that is romantic obtains in organizing a works, because the unexpected occurs everyday, and its anticipation often savours of the marvellous. But knowing that the unexpected may happen, the organizer's mind is set upon meeting the contingency to overcome it. The method is peculiarly human, therefore the human element is essential to all production.

CHAPTER II.

ORGANIZATION.

ORGANIZATION is the key to successful works management; but this does not mean that any mere method of systematizing production will ensure a profit on capital used without the guidance and direction of the human mind; therefore the class of person required to organize is the first stage in the profitable use of capital.

As already asserted, if part of the organizer's duty is a methodical adherence to time limits and personal presence and such times form part of the system, it is simply waste of money to employ a highly salaried official where an ordinary policeman would answer the purpose better at relatively little cost.

It may seem unnecessary to assume that which is an evident absurdity; yet many have an idea that a manager's first duty is to be where the principal can find him at any time. No doubt it will be denied, still it is true, and is perhaps one of the reasons why works management is unsuccessful.

Fortunately the present purpose is practical, useful management, as it should be carried out, and not as it too often is; therefore the class of

person required to organize is what the reader wishes to know about.

The Organizer.—The natural conclusion is that the works manager of any business must be an expert in the particular line. This is advisable, but not necessary, as will be shown in due course. It is quite obvious that an expert used to the manufacture of soap is more fitted to manage a soap works than the man who never learnt the business. Yet it is possible, and in many cases probable, that the novice if an organizing genius, could make a soap works pay far better than the expert who knows nothing, or little, of works organization.

In the following chapters, and for the purpose of simplicity, all references are to works management connected with an engineering establishment engaged in general work.

This is needful, or otherwise little advantage would be gained by multiplying examples, especially as all works management must refer to one particular establishment.

For engineering works management the manager must be a thoroughly qualified mechanic, or rather it is better for him to be such, as it will materially help him during progress, and prevent him relying too much on the experience of his foremen.

Education is essential, and an intimate knowledge of the higher mathematics will often serve him well. As it is impossible to include all in a description of an organizer, it is still necessary to remove wrong impressions, such as that scholastic scientific training is useless, which is unfortunately the idea of many practical men, and on the other hand, the

college-trained student is apt to urge that the merely practical man, meaning the working man, is unfitted for higher official positions.

As a fact both classes need the knowledge they possess and a combination of the two is an advantage.

Let it be supposed that the organizer was originally a mechanic, because it is encouraging to young aspirants for position, and the young mechanic may rest satisfied that if he shows superior ability it will be noticed, and he will reap eventual benefit.

The mere mechanic who neglects educating his mind whilst adding to his manipulative skill will always remain a mechanic, because he cultivates his hands and neglects his brain. The good mechanic with an educated brain early learns that his manipulative skill is enhanced by his superior knowledge, for his brain leads and his hands follow.

Thus, workshop training is as needful as brain feeding, and where the two belong to the born manager it will not be long before he is called upon to occupy an official position. The greater the experience gained—which grows with time—the fitter he becomes for works management, although he may learn much by profiting by the lessons older men have learnt. Whether the initial training has been scholastic or workshop, mere opportunity, without fitness, will not produce the successful works manager. He may be found either amongst the highly educated or in the intelligent workman. From whatever class he springs there is no mistaking the product, because there is something that places him high above his fellows.

Given that the organizer is found, whether he attains his rightful position or not, his future is assured. The pathway to works management is thorny, and those who should help on the aspirant too often try to stop his way; therefore the born organizer is early set apart from those about him, and those above him are quick to note the separateness of his character and appreciate his worth.

Having found the organizer, it is necessary to open the field of operations, and trace out the course he must traverse before he can become a successful exponent of the science, which is measured by his capability to make things pay—this being the end and front of all business enterprise.

In general engineering the need for careful and expert management calls for qualities that are superior to those required to produce some speciality.

The various departments require organizing; the first is Estimating, then follow Drawing Office, Patternmaking, Purchasing Material, Foundry, Machine Shop, Fitting Shop, Erecting and Finishing. All these need special reference; but one other department—commonly referred to as the stores, and affecting the organization of the whole works—must also be considered.

It would be interesting to commence with the establishment of the business, because that is the real commencement of organizing; but the present purpose is best met by assuming the works to be in existence, running full of work, and producing regularly all that a general engineering works is in the habit of doing, including the carrying out of outside

contracts, and probably executing a large amount of repair work.

Estimating.—In very general practice the cost books of the firm are examined and work analogous to that about to be estimated for is reviewed and the estimate, based upon past production, is prepared. Organizing starts right here, and if capably carried out the capital expended in production and revenue shows profit. The present purpose is profit-making, and the work estimated for is assumed to carry a profit which successful works management will ensure.

It only needs a reference to the public contract journals to show that much of a haphazard nature in estimating is going on; estimates prepared from one specification may vary as much as 50 per cent, and very commonly 33 per cent, and the first duty of the organizer is to ascertain a probable cause for such a wide variation.

This brings in a consideration of how capital is utilized, and custom has given the limit period in which capital results in interest. To add to this interest capital is invested in manufacturing works, and the interest allowed by a bank, plus the interest such bank receives from others for the loan of money, represents the full value of interest such capital gathers. Generally the bank interest is 2½ per cent per annum, allowed to the depositor, and moneys lent by the bank carry an interest that varies with the state of the money market, but a fair average is 5 per cent. Thus the manufacturer using capital in business instead of banking it must make what is termed a profit of 7½ per cent. Usually 10 per cent

is considered a good average profit, though many firms make much more and a large number make less.

A safe average to look for is 10 per cent, and it rests primarily on the works management to produce the result.

The present object is to trace a cause why such divergence exists in public estimates where they refer to one set of quantities and productions. Considering the character and conditions of the firms responsible for such estimates there is no need to suppose that the error arises out of mistaking the value of quantities, or even of the actual labour required to be expended on the production, because engineering establishments have gathered valuable experience over so long a period as to make such errors nearly an impossibility, unless it is due to gross carelessness, which is rarely possible where several examinations are made before the estimate is finally sealed.

The cause must be due to the method of estimating by reference to the costs attached to the production of a previous contract of similar or analogous character, and this at once reveals one prolific cause of failure in many instances, showing the result of an improper system, or perhaps a rigid system of management.

Probably the costs used as aids to the new estimate referred to a contract that was completed in six months carrying a profit of 10 per cent. Now, capital used for six months is used twice in twelve months, therefore the profit is actually 20 per cent. Given a capital turned over four times in the year, which refers to quarterly accounts, and where each

turnover carries 10 per cent, the yearly profit is 40 per cent.

Presuming that the costs from which the new estimate was compiled carried this 40 per cent in one case, and in the other only 10 per cent, the cause of the diverging values attached to the varying contracts is accounted for; therefore it must be attributed to improper works management, because such should be responsible for the costing department.

Another cause may be traced to bad management, or it may be rigid system that compels an exigency value to be added, which brings the assumedly net and level value to the estimated value sent in.

When contracting for special work contingencies must be anticipated; but where bad works management exists such addition is largely guess-work, and the fear of charging too little may add so much to the estimate as to prevent the contract being given.

Under good organizing or works management, which is based on a set of averages, the contingency factor, if any, will be probably covered by the average percentage on, say, labour, and as a result the estimate furnished will be much lower than the other, and the contract may be obtained, other things being equal.

With estimates for indoor or works production, the statement is true, but for outside work some consideration must be given to weather conditions, and only ripe experience can deal with the probable contingency on equable lines. Experience in such a case is of untold value; because, probably, somewhat similar contingencies have been met and overcome in the past; therefore the cost is within the knowledge

of the one responsible for carrying out the work. Thus, mere guess-work is replaced by actual knowledge, and given that such a contingency does occur, the cost is covered. If it does not it increases the profit on the transaction, but it is so reasonable that the estimate was not overburdened, so the contract was obtained.

There is still another reason for such wide differences in estimating for public contracts, which is also due to bad works management, or rather from a misconception of the value attached to plant, arising out of adherence to some inflexible system.

The reason why some very low estimate is sent in is based upon the idea that plant value has been fully recovered by a set percentage deducted from revenue every year, therefore no charge is made for machinery, which to such a firm has no value, because the absorbed capital has been wiped out as stated.

Another reason may be that work is needed, therefore the estimate is valued to ensure getting the work.

Many other causes could be revealed, though enough has been said to aid the present purpose, but it is necessary to point out the result.

It is obvious that a firm quoting low to merely get work must, in the long run, deplete their capital value, and eventually fail.

Those firms quoting too high do not get contracts, and in time failure overtakes them, and the Bankruptcy Court is the probable end.

Now, the effect of good organizing may be examined—where works management foresees all difficulties and provides for them, and regularly and systematically produces a profit.

Organizing takes into consideration the amount of capital available and uses as little as possible, but sees to a quick turnover and a prompt return of money value. The object of a good organizer is to produce the greatest result from the smallest capital, and to ensure a good yearly revenue. Estimating has been examined, whereas it should be the last factor in all works management, because estimating is really the outcome of organization, being the knowledge of the cost which will ensure a profit.

At this stage it may require a little qualification; but such is provided for by the elastic nature of good organizing. Now, the use of the term elastic, to some minds, means looseness. That is not true, because the good organizer is always in active touch with all that goes on in the works—directly or otherwise.

Once again the analogy of driver and team is singularly appropriate, because the driver's position is well defined, and his control of his team is perfect under all conditions. It is he who gives the sneezing horse a chance to stretch its neck, but he never loses touch; in fact, the sneeze calls his attention to his charge and makes him more alive to the necessity for attention. Just so is the case of the organizing works manager, whose hands are on the reins of government, of which he never loses grip, but he does allow an amount of give and take which is necessary during the progress of many operations that vary according to circumstances.

Now is the time to enter upon a more detailed account of the number of items included in works management, and to show, if possible, the best

method of aiding progress by judicious manipulation and arrangement.

Though there is no intention of covering all the ground between installation of a works and the production of the finished article, it is considered advisable to briefly go over the ground to enable some slight knowledge of what installation means, because it forms the foundation on which much of the profit-making is based.

Another reason is that works management should include all and everything, from inception to finish; therefore a general idea of all the organizer has to negotiate will serve the useful purpose of fairly valuing the qualifications needed to meet the demand.

Capital is the first essential, and it matters not how long or short a period may elapse between installation and realization, capital must be kept intact at the end of the time, and this can only occur where it has been used profitably.

Installation of Works.—The assumption is that land for installation is available, but whether freehold or leasehold it represents capital value. If freehold, its value is presumedly recoverable at any time without reduction. During the period of its occupation, as works land, it may not suffer depreciation—still it must bear the cost of taxation, which must be recovered from revenue, or the capital value will suffer. The capital sunk in land must pay interest, which can only be done from revenue, and this is the first item work's management must consider.

If the land is leasehold, it represents so much

capital paid down, or a yearly rental, and a proviso may be included in the lease for the payment of a fine at the period of renewal. Suppose the lease is for twenty-five years at a rental of £200 per annum, and the payment of a fine of £1000 is due at the end of the time, if the lease is renewed on the old terms. If it is necessary to remove the works at the end of twenty-five years, the cost of such removal must be considered, and the £1000 is available to aid the cost.

In case of the freehold—supposing the purchase price is £4000, which is presumedly recoverable at any time the land is sold again, interest must be taken out of revenue, which is a first charge that works management must consider. To this must be added the value of rates and taxes, which is recoverable from revenue, besides the interest for its use over one year. Thus, interest per annum, plus value of rates and taxes, plus interest on the same is a first charge on revenue. In the case of rates and taxes, the full value is returned to keep up the original capital; but it, like every other disbursement, and the interest derived from it, must be taken from the yearly revenue.

Under the leasehold conditions the rental and interest must be deducted every year to reinstate capital and to pay for its use. Rates and taxes still go on, and even, as under freehold conditions, they are recoverable from revenue; but an additional charge is required over the term of the lease, being the value of the fine, which is capital value to be expended either on payment of the fine or on part payment of removal.

But land, whether freehold or leasehold, needs preparation prior to putting up the works. Probably 10 per cent of the purchase value will be required to get the land ready for building purposes. In the case of freehold it adds to the purchase value, and is presumedly recoverable by sale, but in case of the leasehold it is spread over the period of the lease, and both principal and interest is taken out of revenue.

Thus land, and all that pertains to it, including drainage and sanitation, represents money, and is a first charge on revenue which works management must consider when organizing.

All these items come under the head of indirect or dead expenses; but whether indirect or direct, every item of expenditure must be allowed for and recovered before a profit can be declared.

It is too obvious to need explanation that under the two heads any and every expense from the crude land to the finished article must be included in revenue, and beyond that revenue must include a fair profit. To get this profit is the object of all works management.

Let it be supposed that works management has to do with an existing establishment, running fully equipped, and in active work, producing what there is a fair demand for at a price that custom and experience has proved to be sufficient to incite custom, and yet leave a fair margin of profit.

Let it be assumed that new work has been sought and obtained, under contract conditions; it rests with the works management to complete the same in the shortest possible time, at the least cost, and leave a profit at the end of the transaction.

The usual custom is to add a percentage to wages, which is assumed to cover every indirect expense, and other things being equal, a successful end is reached.

It is this percentage value in which danger lies, because it may be as low as 50 per cent on wages to 200 per cent on the same. All departments are involved in this deduction, but as they vary as the values given, the task of works management is not simplified. Touch with the progress of the work must be kept all the way through, or inevitable losses will occur, and works management will be discredited.

A clear idea of the value of every department is essential, but it is equally necessary to know their disabilities as well, and by anticipation the organizer is ready to meet difficulties as they arise without causing needless delay.

Whilst it is not necessary for an organizer to be a really practical manipulator, it is a decided advantage, because his practical knowledge will serve a good purpose in directing operations, even of details. Workmen are merely human and are influenced by superiority, and where manager and foremen are experienced mechanics, there is less likelihood of a dishonest workman trying to hide bad work; besides, his superiors' commands are more readily obeyed. Further, the knowledge that his superiors know what the workman calls the ropes will make men careful that such ropes are kept in good order. This does not mean that an official could manipulate the work in hand as well, or better, than the workman; but it does mean that given manager or foreman were in as good training as the workman, they could

do a piece of work as well, or better, in a given time. Where the officers are of this calibre work progresses much more easily than under other conditions.

The same thing refers to all the departments, including the drawing office. An organizer who is also a draughtsman is saved a large amount of worry and anxiety, because he is able to follow every detail to its finish.

The Drawing Office.—Whatever may be said to the contrary the drawing office staff are valuable adjuncts to works management, and it is a mistake to spare expense, where money can be saved, perhaps, more easily than in any other department.

Assuming that a new contract requires a complete set of drawings, the starting stage of good organizing commences in the drawing office.

The first set of drawings to be produced is the complete machine, or whatever it may be; but they must be in pencil, and when these are complete, manager and foreman, with the chief draughtsman, must subject the plans to a critical and expert examination. If the drawing office head is of the highest class such an examination is the more necessary, because such a man is imbued with high-class artistic ideas, making him capable of producing something that possesses artistic excellence; but it may be an excellence that is too ornate for the price quoted, and too elaborate for the class of workmen and plant to manipulate.

The executive staff will not sacrifice anything to utility, but they will to appearance, and under a capable manager mere captious criticism will never interfere with a practical and whole-souled examination. The various heads of departments desire the

simplest and most direct way to a finish, and any fancy that adds to the future marring of progress will be stopped at the drawing.

After hearing opinions and seeing their reasonableness, the manager and chief draughtsman cogitate as to the best means of meeting the wishes of the heads of departments, and when the general drawings are brought into line with the ideas expressed by the examiners, the drawings should be inked in, and kept as a standard of that particular contract.

Preparation of the detailed drawings is proceeded with, and whilst they are still in pencil the foreman of the department in which the detail is to be carried through, in conjunction with the chief draughtsman, subjects them to critical examination, and when both are satisfied the initials and date of both should be written at the left-hand bottom corner.

Some drawing of the frame, or other part to be cast, may strike the draughtsman as being similar to a pattern produced for another job. It may require alteration, but before this is settled the foreman pattern-maker is asked his opinion. If the cost of alteration is little, and not likely to cost much to reinstate it to its original form—if required for the original casting—the work can be done.

As the drawing office is the cheapest place to make experiments in, so the pattern-shop is the cheapest department to save future expenditure of money.

If a pattern can be altered at little cost, or the cost of alteration for the new job, plus the reinstatement to the original if required, is less than the cost of a new pattern, then such alteration is notified on the drawing.

When all the detailed drawings are passed and the manager has expressed his approval by putting his signature in the left-hand top corner of each drawing, complete schedules of quantities are drawn out on separate sheets, made in duplicate.

Each drawing is inked in, and figured dimensions are added, which must be worked to, the class of material to be used, the style of finish, in fact, all that has to be done must be noted. Thus every drawing portrays faithfully all that the production must be, where nothing is left to memory; even the chamfering of an edge or the rounding of a corner should be noted and written in plainly. Under no circumstances should it be necessary to use a rule upon a drawing, therefore all dimensions must be figured in clearly and distinctly.

In this way the drawing is the epitome of the complete detail when finished, and as every drawing bears a consecutive number, and the number and description of the job, needless inquiry is prevented, and time and money is saved.

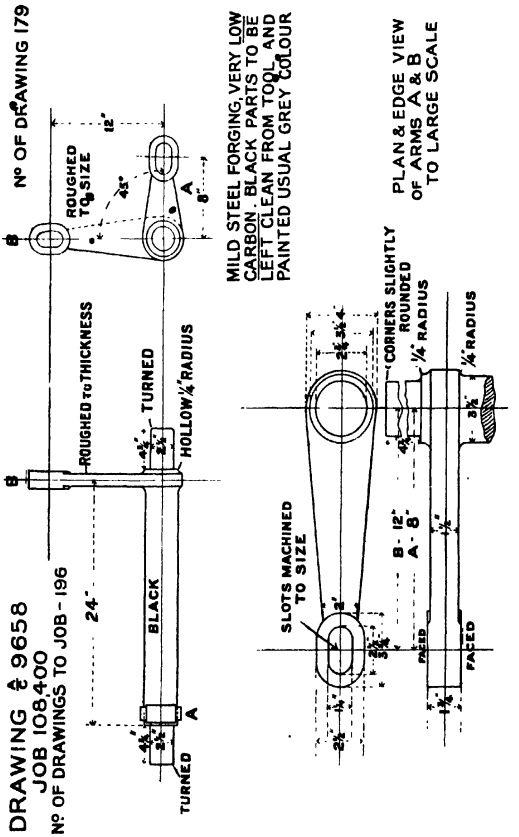
The following is an example drawing:—

DRAWING 36A.

Job 5000.
Number to be made (20)
Rocking Shafts. Mild steel.

INSTRUCTIONS.—Turned, shaped, slotted, and drilled to dimensions. Eyes and ends of shaft case-hardened, and got up bright. All other parts to be painted with one coat of *grey* priming paint. All sharp edges to be eased off, also edges of slotted holes in end of arms.

Signature of Manager.



B arm same dimensions as A, except length equal 8 inches.
All shoulders to be left hollow in corners.

Signature—Chief Draughtsman.
Smithshop Foreman.

Note.—All drawings to be made to scale, but as many enlarged sections as possible to be made to enable figured dimensions to be clearly written in.

Duplicate schedules to be prepared, giving full particulars of every detail and their number, for the manager's use. One he would hand to the storekeeper to be dealt with in a way to be set out in due course.

It may be possible, though not usual, to charge the drawings directly to the job in hand; but it is better to charge all drawing office expenses to the indirect expenses account, especially if the drawing office is used as the place for what may be termed experiment, being the most suitable and the cheapest department, because little of material value is used, and experimenting on the drawing board to bring the design into line with the capabilities of the works plant and facilities of the works is good organizing and wise works management.

An example of what the schedule should set out is as follows:—

Job 5000.—Schedule of quantities for 20 drilling machines as drawings from 1A to 70A.

Contract received 6 January, 1900; ten to be delivered before July, 1900, and the remainder before September, 1900.

For terms of contract and conditions, also character of work, see agreement marked *Job* 5000.

Number of Drawing.	Class of Material.	Number of Parts.	Class of Operations.
37A	Cast Iron	20	Pattern, Foundry, Planing, Drilling, Fitting.
36A	Mild Steel	20	Forge, Turning, Slotting, Drilling, Hardening, etc.

The schedule for manager's use to be amplified by giving all information as recorded on the drawings, and to be a sort of ready reckoner, and an epitome of the complete job, including the most minute details.

Pattern Department.—Next to the drawing office comes the pattern department, and the foundry foreman should be called into council, because time and money can be saved where the patterns are produced to suit the requirements of the foundry.

The pattern-shop must be large enough to permit the work to be done expeditiously, and it must be provided with labour-saving tools, wherever necessary, to facilitate operations.

The best and driest wood is the cheapest in the end, and ample machinery is likely to save money; but to merely copy another firm's pattern-shop which is fitted with every conceivable labour tool on the market is not always economical, or indeed wise, for such a firm may have everything up to date, yet be an unprofitable undertaking.

The works management is out to save money and not spend it; therefore conditional factors must rule expenditure.

Where the introduction of machinery can show an actual saving at the end of the financial year it should be adopted; but to have a lot of expensive machines working one day and standing five cannot be good management. Good organizing and works management rarely concerns itself with a mass of detail, but generally deals with percentage values; because such merely have to do with wages and not with the number of men employed.

It may be taken as an axiom that a given percent-

age value for a given wages bill may be the maximum, and a larger wages bill may mean a reduction of percentage under good management.

For an ordinary pattern-shop forming part of a general engineering works, probably a 3-feet circular saw bench, another 18 inch, one large chuck lathe and two smaller ones of the ordinary woodworking type, including a 36-inch grindstone and a pair of emery wheels, all power-driven from the factory engine, may be deemed a fairly good equipment.

The suggestion is merely arbitrary, to furnish a base to show how a percentage value on wages is arrived at.

We will assume that the necessary machinery, a properly covered-in wood store, well stocked, and ample pattern storage room are provided; we then have a sound foundation for valuation.

Probably £250 will cover plant outlay, and the life of such plant is, say, fifteen years, giving about 16 guineas per annum to be deducted from revenue to recoup outlay over the given time; but allowing another £50 for fixing, £300 is the actual outlay, giving £20 recoverable per annum. Still another addition must be made, because the machines occupy space and must carry their share of rent, rates, and taxes, gas, water, and power; besides interest on the capital involved, which latter may be taken as an average of £4 per annum, making a total of £24 per year, to be taken from revenue to meet the complete recovery of the original outlay and interest. Call it £25, and assume another £25 will cover rent, etc., or £50 is the first item on which a percentage value is based.

Patterns suffer a depreciation of 33 per cent, and probably 25 per cent of all the value of wood used is wasted.

Now, taking this £50 as covering fifty weeks of fifty-four hours each, it makes the hour charge about 4½d.; but the machines are only at work one-third of the time, and as one-third = 4½d., three-thirds = 1s. 1½d.—the actual charge value per hour of use for machines.

On such lines fully £150 is required per annum for machinery charges, to which must be added depreciation and loss of wood by waste.

Suppose waste wood means £250 per annum, and depreciation, etc., equal £200, the total is £600, to be accounted for as a percentage on wages.

Let the wages include foreman £3, three pattern-makers at £2 each, and two apprentices at £1 each, equal a total of £11 per week, or £550 per annum; then as 550 : 600 : : 100 : 109 per cent of the wages must be added to wages.

These figures are merely assumptive, but in general practice about 110 per cent on wages is the average for the pattern-shop expenses. Though only approximate, an object lesson is presented to show how increased wages reduce the indirect expenses.

Given the wages are £15 per week, or £750 per year, the indirect expenses, assuming they are still £600, only represent about 80 per cent of the wages; therefore the works management endeavours to keep the works running at full pressure because more profit is made.

The pattern-shop indirect expenses do not remain at one figure, because depreciation on patterns is

increased as more patterns are produced for the given wages; besides, wood wastage is presumedly in proportion to the wages paid, therefore the saving is effected by the nominal value of what may be termed plant, etc., equal £150 per annum. Thus works management can still take advantage of full running to reap a better profit than when running slack.

This brings to the front an expedient often adopted, viz. to take work that will not allow a profit direct, but by keeping the works full, indirect expenses percentage on wages is lower, and the difference is an advantage, that is profit.

The average percentage on pattern-makers' wages is, say, 110 per cent; to meet indirect expenses keeping the pattern-shop fully employed may easily save 10 per cent; therefore profit is assured, although the estimates sent out do not include any profit as based on ordinary lines.

In a sense, the argument stands good for every department, because, as a general assertion, the value of dead expenses are stationary where wages may be of low or high value, for which reason an average and not a floating percentage on wages will generally cover all conditions and ensure a profit always.

This is argument, but it is qualified by what practice teaches, and as works management deals with principles rather than details, attention to the ground principles must be urged.

The next departments to receive attention are the brass and iron-founding, usually and preferably under one management.

At this stage something must be said in regard to a very important part of a general engineering establishment—the foundry.

It is hardly necessary to say that successful foundry work requires good equipment, careful attention, and good management, but it must be deferred to another chapter.

CHAPTER III.

BRASS AND IRON-FOUNDING DEPARTMENT.

ANY attempt to cover the ground of practical iron-founding would be to depart from the present purpose; yet the works manager must have a knowledge of the principles underlying the successful outcome of one most important department under his charge.

The manager's wisdom incites him to employ an expert as the ruling head of the foundry, to whom all details are left, and where such head is thoroughly competent it is bad management for the works manager to interfere unnecessarily.

As the name works management implies, it means exercising organizing ability, to use the abilities of others to the best advantage. Yet the responsible manager must be able to aid the ruling head of the foundry by good advice when required.

Fortunately for all concerned, foundry practice has eliminated much that is fancy, and consolidated a great deal that is universally adopted.

Works management recognizes the possibility of exigencies, and is prepared to meet them, therefore the experience gained by the foundry expert is valuable, and should not be neglected, or overruled, unless proof can be produced that such experience is valueless as a productive factor.

In foundry practice the unlikely often happens, and it is here especially where the expert practitioner shines. He has met such happenings, and though they may seldom occur, he expects them and is ready to combat their evils.

Mixture of metals is an important part of the foundry manager's knowledge, and on it successful output rests—even as the final result is largely due to the character of the metal used.

Another part of foundry practice concerns sand, and even with a foundry up-to-date in all things but sand, ruin may easily occur by inattention to what too many look upon as a sort of necessary adjunct to foundry work, instead of being a factor of vital importance. When a handful of foundry sand is squeezed in the hand it should cohere—that is, hold the shape impressed upon it; unless it does this it is useless for the purpose intended, but cohesion is only one essential feature. Another feature of good foundry sand is its capability of retaining the form impressed upon it, yet allowing gases to escape by the interstices between the particles.

Moistened clay will retain its form, but it will not allow a free passage of a gas through its pores, therefore it is useless for foundry purposes.

Still another factor is necessary; foundry sand, which is largely silica, must be sufficiently diluted or mixed with other ingredients to ensure non-fusibility under the intense heat of the molten metal poured into it, and one test of this essential is that it will readily leave the casting after the metal has set sufficiently, leaving a clean and smooth skin.

Generally, moulding sand must be capable of re-

taining the form given to it, even to resisting the pressure due to, sometimes, a considerable head of metal, and allow the escape of gases given off by the hot metal, whilst its resistance to heat should be sufficient to prevent its melting and spreading itself over the face of the casting as a sort of glass.

But one class of sand will not do for all purposes, and it is here where good works management scores in seeing that the sand suited to every purpose is obtained, and the result will pay in good castings with the minimum of waste.

It is rather a fine art to choose the right sand for the right work. For a flat surface a comparatively weak sand—in cohesion—will do, whereas a strongly cohesive sand is needed when minute projections and depressions form the feature of the pattern.

Many classes of sands are used in foundry practice. Green-sand moulding is the name given when the moulds are used in an undried condition, whereas dry-sand moulding means that the moulds are dried in a stove before metal is poured into them.

Loam sand is worked when like stiff gruel, and is generally used without a pattern, and in general practice the mould is built up roughly to shape, leaving a superfluous quantity on which is swept off and the shape obtained by a strickling board.

Another sand is used for making cores, and is generally a mixture of loam and ordinary sand. The cores are usually formed on a metal spindle wrapped around with straw; when the core sand is applied in sufficient quantity to allow for the required size afterwards, it is brought down by the strickle-board.

Another class of sand is used for the surface of a mould where two surfaces are joined together. Its usual name is parting sand.

Still another sand is used to face the moulds to ensure to the casting a smooth skin. Graphite, mixed with suitable sand, is often used for this purpose in a state sufficiently liquid to be applied with a brush. This fills up the pores and ensures a smooth and even surface to the casting which is essential to good work.

A carelessly prepared mould may produce a sound casting, but with a skin so rough as to mean the expenditure of time and money to get a smooth and even surface; therefore careless hustling when mouiding does not mean economy.

The great mistake is to allow the foundry sand floor to be used so often as to deteriorate the quality. This is too often allowed because it costs money to replace it; but it is better to replace foundry sand at a small cost than use it and pay several times as much to get the castings to the necessary smoothness.

Silica is the chief ingredient in all sands, and its percentage value ranges from 77 per cent to 96 per cent, according to the class of material the moulds have to resist. The lowest is used for light brass castings and the highest for steel; but generally it is divided into five sections: viz. for brass, light iron, medium, heavy iron, and heavy iron and steel.

Now sand possesses so many impurities that all sands should be carefully washed, or otherwise treated, to eliminate any superfluous soda or potash, which will clog the pores and destroy porosity.

Generally every expert foundry manager knows

the class of sand best suited to the purpose intended, and to insist upon such a man using material he knows to be uneconomical is unwise and indicates bad management.

Perhaps the most important sand is that used for facings, because on it rests the production of well-finished castings that will save time and money on the complete machine to make it presentable.

Facing sands require careful screening through a fine-mesh sieve, but the consistency is largely a matter of experience, and all the works management can do is to provide the material, and the man who knows how to use it will see to the rest.

This is especially true for brass castings, and in general foundry practice good management means using the best material, and using it as long as possible, but never allowing it to deteriorate.

Using moulds before they are thoroughly dried is both dangerous and bad practice, because it often means spoilt castings and that means lost profit.

Facing sands for different purposes require different methods of application. For green-sand castings it is applied dry by dusting it on, and for dry-sand castings it is painted on.

To attempt anything like analysis of facing ingredients would serve no useful purpose, but plumbago and water are found to be useful for medium-weight castings.

It is needless to say that all facing compounds are powdered. It is thus evident that works management in foundry work requires expert and experienced leaders if good results are to be reached.

To the embryo works manager it may be of some

assistance if even an outline of some of the tools used are named, because it gives an idea of the dead expenses side of foundry work. About twelve hand tools are in general use by the moulder when preparing the moulds for casting. These tools are for cleaning, surfacing, building up, and ventilating. But these are mainly personal to the moulder and need not concern the management, because even if supplied by the firm they are inexpensive, and would make little difference to the final result sought for. These will include several sizes of soft-haired brushes.

Other tools used by the operators are supplied by the firm, viz. rammers of various shapes, but all are used to give homogeneity and compactness to the sand moulds, because sand requires detailed manipulation.

In this connexion many moulding machines are often damaged by the mistaken idea that given enough sand the pressure applied will ensure the sand being forced into every corner, which is a mistake, because sand by its very nature, as moulding sand, does not slide easily upon its own particles.

To enumerate all the tools used in the foundry would make quite a long list, and though it would be interesting it would serve no useful purpose to name them, because works management does not give special attention to details, as mere details, but as a means to an end ; but there are expensive tools that must be noticed, such as sand mills, sifters, screens and mixers, and moulding boxes and cupola accessories.

The first four named are generally power-driven and require expenditure to ensure their upkeep, be

cause they wear out quickly, meaning that their life is short and renewals are frequently needed, and these with cranes, etc., go to make up foundry plant.

Weights of various shapes for loading down the moulds prior to casting are essential, and with the casting boxes they represent considerable weight and value.

Moulding cramps, trestles for core-making, lifters, carrying tongs, ladles, both for hand carriage, wheeled carriage, and crane-lifted, according to the nature and weight of the casting required, are also employed

Some ladles are very large and fitted with gearing for tilting, or to allow a discharge from the bottom.

It is quite obvious that all ladles must be lined with refractory material, or the hot metal would fuse the metal, which is generally steel. The lining may be sand or other material that will hold its form when baked dry, which is necessary to all ladles if fireworks of a destructive and unpleasant character are to be avoided. The same thing may be said of the moulds which must be dry before pouring.

The writer gained this experience at an early age, which might have had disastrous consequences but for prompt measures. It served a useful purpose because it taught the lesson that hustling in foundry work did not pay.

Works management means organized arrangement to meet exigencies which are inevitable in all works operations, and perhaps more exigencies occur in the foundry than in any other department.

In foundry practice every fresh mould presents some new difficulty, which is peculiar to itself, and whilst experience may mitigate such, it cannot

eliminate all; therefore anticipation, always on the alert, is prepared for all emergencies.

Generally a mould is only proved by pouring the metal, and the resulting cast shows if the mould is good or bad. It is safe to assert that a bad casting is due to some very minor fault, and if one faulty casting is produced there is no reason why another should be off the same mould, or rather pattern.

The fewer the wasters the better the management; but if any management assumes that there need be no wasters, the awakening will be severe. Wasters may be due to the mould, but it may be due to the metal, and the practical moulder soon finds the cause and sees that the remedy is applied in future cases.

A badly jointed mould may allow a run-out, which means bad work, and this may be due to either imperfect jointing or insufficient weight, or it may be due to bad venting. In any case it is bad practice, and condemnable in any foundry.

Another cause for waste is a poor pour, which is inexcusable, because it means bad calculation, but there are other causes for wasters not so easily defined; yet experience teaches how to avoid them. Where a long run of thin metal is spread out over a large surface, or where high runs of different heads are necessary, there are likely to be faults due to the metal not running fluid enough. This is especially true when only one gate is used. Hot fluid and prompt pouring by more gates is a remedy that seldom fails. These matters have to be considered in works management, but they are usually met by employing the right men to do the work.

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cause they wear out quickly, meaning that their life is short and renewals are frequently needed, and these with cranes, etc., go to make up foundry plant.

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Scrap should be carefully sorted, and all dirt eliminated, and when a good mixture has been found suited to a class of work, a careful memoranda of the mixture-quantities must be kept and adhered to, otherwise the end will be doubtful. All these various operations cost money; but keeping the cupola in good order is a most economical factor in a good final result.

Quite enough has been said to show how important all that concerns the foundry is to works management.

It is well known that many an old-fashioned foundry turns out castings superior, or equal, to the most up-to-date production from a modern plant, and the reason is the very old one, that poor tools in the hands of a good man are sure to produce a better result than good tools in the hands of an inexpert craftsman; therefore good organizing means the use of the best all round, and it pays.

Works management depends largely on the human element, and the individuality of the managing head has a direct influence on the final result.

This brings in what has already been referred to, viz., that the works management is most concerned in knowing how to utilize the least efficient things to the best advantage, and the best to obtain ideal results.

It is decidedly an advantage for a manager to know details, though it is not absolutely necessary; but it is not only essential, but absolutely necessary for works management to recognize ability and be able to use it to the fullest extent.

In regard to the foundry, the responsible head

must be experienced as a practitioner, and have a sound practical knowledge of metallurgy, besides being able to show the best workmen the best way to produce best results.

The equipment of a foundry is an expensive outlay, representing a very large indirect expenses account; therefore foundry costs are important to all works management.

So many are engaged in such productions that the labour cost is high, relatively. Taking the foundry operations in sequence it is evident that moulders, dressers, labourers, attendants for furnaces, foundry manager and assistants, clerks, etc., are all human elements included in the wages bill, on which a percentage must be placed to cover all dead expenses.

Generally the wages account referred to the weight of castings turned out in an iron foundry is under £4 per ton. Such an average is safe; yet it does not provide a foundation for charging up work done, because some castings are more expensive to produce than others; for instance, fire-bars or plain castings require less labour expended on them than an engine cylinder or other intricate production.

As a rough indication a series of values are given representative of different methods of production which at once shows the variation of skilled and unskilled labour needed. Three divisions are referred to, viz. green, dry, and loam work, and taking the skilled labour charges in the order given, relative costs are as 100, 78 and 86 per cent; whilst the unskilled labour, also in sequence, is equal to 16, 20, and 50 per cent of the skilled value.

Now it may happen that green-sand moulding

represents the complete output for, say, one week, therefore only the smallest ratio of unskilled labour is utilized, though the full value of such labour must be accounted for.

The condition will be rare in general work, therefore an average must be struck, which may mean 33 per cent to be added to account for unskilled labour. By this method unskilled labour is referred to the indirect expenses, and as unskilled labour is included in the maximum labour charge of £4 the reduction by 33 per cent makes it £2 14s. per ton of castings. This means that a percentage sufficient to cover all indirect expenses in regard to the foundry is referred to the wages of the skilled artisans

The following deduction is merely arbitrary, but it is near enough to give a general idea of the value per ton of castings turned out.

Assuming that it cost £2 14s. for skilled labour to produce 1 ton of iron castings, and that 100 per cent will cover indirect expenses, then £2 14s. plus 100 per cent = £5 8s. To this must be added cost of metal and fuel, taking metal at £4 per ton and fuel at 4s. for every ton of metal, then metal = £4, fuel = 4s., and say flux, such as limestone, equal to a similar amount, the total value per ton comes to £9 16s. Adding 10 per cent we get £10 15s. 7d. per ton as the average price for iron castings.

Some castings may be sold or valued at £7 per ton and others at £15, but an average of £11 per ton may be considered a reasonable average price to sell outside of the works.

Quite a simple rule makes rough estimating easy,

viz. £2 14s. × 4 = £10 16s., or 4 times the skilled labour value per ton gives the average selling price, to allow a profit of 10 per cent.

This rather extended reference to foundry practice accentuates the assertion that organizing must allow some flexibility to meet variations, and it also shows that there is no royal road to successful works management; and systematizing to red-tape standards is useless as a profit-making method. But it shows also how works management is utilized in foundry practice in the successful production of a complete machine or engine from raw metal.

Before the end is reached many problems have to be solved, and innumerable difficulties must be overcome, and the successful organization of the foundry involves utilizing the best, and reducing the indirect expenses, without in any way interfering with, or destroying, final excellence.

Whilst there is no intention of attempting to give even an outline of foundry practice, it is still necessary to furnish an idea of the variety of detail that occurs between the production of a simple pattern and the casting derived from it if works management is intended to give a profitable undertaking.

A general impression will be gathered from the ensuing chapter that it is necessary for the embryo manager to understand a great deal ere he can hope for any measure of success.

CHAPTER IV.

BRASS AND IRON-FOUNDRY INSTALLATION.

BRASS and iron-founding need not be dealt with separately, because they both come under one department; if they do not, it is a mistake in works management, as both should be under one responsible head.

Very loose ideas in regard to foundry practice exist, and many a fiasco has occurred by thinking that any ground is suitable to install a foundry, whereas site and nature of ground require more than ordinary attention.

The present object has nothing to do with the nature or character of the building, but only with the site, and whilst a foundry floor may merely suggest digging out to a depth of 12 inches and filling in with moulding sand, that is really only the commencement, because in a general engineering foundry some patterns or moulds may require a considerable depth below the floor level, which means digging out a hole, and in doing so swampy or water-permeated ground may be reached. Such cases have occurred, and before the ground has been fit for foundry purposes endless worry and enormous waste of money resulted which might have been avoided if proper attention had been paid to the character of the

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cause the nature of the work done settles the question of boxes, though in a general foundry the estimate is not too high.

Whatever the size of the foundry it is always wise to have two cupolas, one always in work whilst the other is ready to meet any contingency.

Any weights beyond 2 cwt. compel the use of some class of lifting tackle, either cranes or overhead travellers, and these should be of good construction and fully equipped to meet all demands.

Many other things are essential, but nothing must be installed unless it is likely to save expense and reduce the cost of management.

Rent, rates, taxes, office expenses, staff salaries, etc., must be allocated to the foundry in proportion to its capital value and the space it occupies in the works.

It has already been assumed that 100 per cent on skilled labour wages will cover all indirect expenses, but it may be regarded as possible to reduce this to something like 85 per cent, but only when the foundry is kept at full power.

It is a mistake to imagine that cheap materials, simply because they are cheap, will assist in producing a profit. The opposite may be the case. This does not mean that buying in the cheapest market is a mistake, but it does mean that buying poor stuff at a poor price is always dear in the long run.

The continued use of foundry sand after it is impoverished only leads to trouble, and is an evidence of bad management; indeed any makeshift is to be condemned, because it does not pay.

As in the case of all other departments, a fund

should be instituted for use of the foundry when exceptional work has to be done which cannot be charged to the job. Thus a contingency is met which will not occur again for a similar job.

The pattern-shop should be run in unison with the foundry, and by definite colouring, the moulders should be informed which faces have to be machined, and arrange that these will bear planing off.

The body should be of one invariable colour, and facing parts should be indicated by a different colour, the cores being always made black. Generally, the body colour for brass or gunmetal is red.

By attention to these small details time is saved, and no questions need be asked, and faulty castings may be avoided.

Many castings fail because shrinkage has not been provided for, and it is here that the combined consultation of foundry and pattern-shop officials produces good results.

A few conditions resulting from natural laws must be referred to, such as that all moulds have air in their spaces and hot metal expands it; also that gases are given off from the metal and the facing sand in contact with the molten fluid.

These facts make the necessity for venting essential. If it is neglected, a bad casting is sure to result.

Dirt is another source of endless trouble, and many a casting, apparently surface sound, may show deep honeycombing when the surface is machined off.

Any number of "don'ts" might be tabulated, and an equal number of "musts" could be as easily noted;

but these are matters that any skilful moulder or experienced foreman knows and that need not be repeated here, because works management involves the employment of the best men to do the best work.

Foundry machinery, in fact all that concerns foundry work, soon wears out and therefore depreciates rapidly.

The works manager notes every source of expense and that gives him the foundation on which to organize. As a fact, be it foundry or any other department, every detail has a value, and it is the total that the organizer considers when placing a percentage value on skilled labour.

Moulding and casting large-size cylinders gives much trouble, because of the intricacies natural to the production of the mould and running the casting.

Given a pattern and a good moulder there is little fear of a poor result, but one common mistake is to ignore the value of correct ramming, which is really a scientific operation, on which the final issue often rests for a good or bad result.

Thorough drying of a mould helps the expulsion of gases after they are generated, because the pores are opened and all moisture is expelled or dried up.

The expansion of irons used in supporting parts of the mould or cores help venting, and this is especially true where hangers are utilized to support parts below the top.

Finishing a mould is perhaps as important as anything else, because on it rests the appearance of the casting, and unless great care is exercised a scab (i.e. a combination of blisters) is likely to mar an otherwise beautiful skin appearance.

After drawing a pattern the duty of the moulder is to see that all parts are sound. If not he must make them so with the tools at his disposal. Only when this is attended to must he finish the surfaces; but on no account must he polish any surface so as to cover the sand pores, which will likely result in scabbing.

Cores must be very carefully placed, especially those which will leave holes that require boring, because a badly placed core may easily represent a great loss when machining.

Core-making seems quite a simple matter, as it is, but it is highly important not to ram too hard, or the core will vent badly. Every core should be thoroughly baked and be porous all through and free from glazy surfaces, as these will leave blisters and hard spots which are hard to dress, and harder to machine.

Generally speaking, all blistering is due to bad venting which can be avoided by care and attention.

Chaplets are pieces of metal used to hold cores in position to prevent distortion and take many shapes; they give the careless moulder an excuse for blisters; but the cause is usually that already named.

Whilst this is true none should be placed in a position where the part has to be polished; not because the chaplet is bound to leave a scar, but only to avoid any chance error in fixing.

Many practical methods are adopted when using chaplets, but none will take the place of skilled attention.

Rusty chaplets are always bad, therefore they

should be kept in a substance that will prevent rusting.

In casting engine cylinders of the common type the bore sometimes becomes scabby at the top, at or near the centre. This is probably due to a bad foundry floor which compels the cast to be made with the exhaust outlet at the top. In such a case the riser may spring from the exhaust outlet flange, which curtails its size, but often the riser is totally inadequate to ensure a sound casting, and as a result the impurities float to the top, and when the cylinder is bored a considerable honeycombing may develop.

All such cylinders should be cast with the bore vertical; this allows risers of sufficient size to ensure a sound flange, and can be easily arranged.

It is quite obvious that good moulders and an experienced foreman will avoid many of the faults mentioned: besides, it is the wisdom of a good manager to get the best men who know their work, and then to facilitate their operations by a liberal attention to their wants.

The foundry manager is an important human element in any works, and should be paid accordingly. In no sense need he be a specialist in one class, but he must be an expert in all. In the hands of such a man foundry work is safe, and the works management is wise when such a man is appreciated at his right worth.

Closing in a mould is one of the most intricate operations the moulder has to perform, and its successful accomplishment proves him to be a master of his art.

After the closing comes the gating for pouring

into the mould and the outlet from it. The positions of these gates are important, because the best mould may be sacrificed to a bad pour or an inefficient riser. The first is best placed to pour into the bottom of a mould, and it matters not what the mould may be; with few exceptions the bottom pour is the best.

Obviously the outlet or riser must be above the highest part of the casting, and be sufficient to ensure good clean metal above the highest part. The inlet or pouring gate must be larger than the outlet or flow gate to ensure the solidifying of the molten metal under some little pressure.

Chilled Castings.—In a general engineering foundry chilled castings are often required; but few men appear to understand what chilling a casting means, or rather how it may be done.

When a hot metal is poured into a mould, some part of which is cold iron, the surface becomes chilled. When metal is poured round an iron core or into a metal mould the surface is chilled. Obviously the surface of the cold metal must be protected, and that is usually done by covering the surface of the chill with tar, which is said to be the best and most simple protector.

Chills, especially those of cylindrical form, are likely to crack with the hot pour, therefore they should be thoroughly hooped with metal rings. As this is not a work on iron-founding it is unnecessary to outline the methods adopted for casting complete articles in iron moulds, that are not chills in the sense of imparting a close-grained surface to the article moulded.

Loam Moulding.—An endless variety of details

have to be attended to in foundry work and the neglect of the most simple may easily mean spoilt work and lost money. In general foundry work, loam moulding is very much to the front, because it lends itself to moulding forms without the expensive expedient of a pattern. The foundation, as in cylinder cores, may be brickwork covered with loam beyond the size required, which is then swept to size and shape by a board of the form required. Cylinder cores, screw-propeller blades, and many other articles are loam moulded. With loam and a few former boards and the aid of moulders' tools an intelligent moulder can produce an artistic and good mould without a pattern.

Loam moulding is commonly regarded as an expensive method of obtaining castings, and in a sense this is true, but only partly so, because expense in one direction is saved in a pattern, so that extra time and money may be expended on a loam mould; where the second is of less value than the first the result must be economical. Here again pattern-shop and foundry can be utilized in the hands of good management to save both time and money and largely increase eventual profit. Whilst loam is used for exceptionally heavy work it does not mean that it is not useful for the lighter; in fact loam moulding is suited to any class of work, and in the hands of an intelligent loam moulder marvellous results are possible.

Loam moulding may fitly be termed modelling in wet sand, and it enables the artistic temperament free play; therefore it is to the moulder what the higher mathematics are to the ordinary scholar—a proof of a superior ability.

Perhaps the romantic side of works management is more in evidence in foundry practice than in any other department of an engineering works, because possibilities are often reached by flights of fancy that hitherto had appeared to be improbable.

The student of good works management very naturally strives to grasp every detail, whereas the successful works organizer endeavours to show his knowledge of detail by a careful treatment of his staff; because it is a good axiom, already referred to, for the manager never to do what some other person may be able to do better, and this policy pays if only for the reason that the management is freed from attending to mere detail, leaving hands and brains clear to tackle difficulties as they arise.

Brass-foundry.—What has been said of the iron-foundry is also true of the brass, but in a minor way, though the brass-foundry is that from which many a machine or engine gets either a short or long life.

Starting a brass-foundry as an adjunct to the iron-foundry does not represent a big outlay—a limited space cut off from the larger place, fitted with two or three crucible ovens, or furnaces, in which the metal is to be melted. At least two should be installed in even small foundries, because anything happening to one means stoppage with only one, but it is only a minor nuisance where two exist. One or two moulding machines of simple type are good, a few casting boxes, one or two moulding tubs, and a few tools, including storage room for sand and fuel, and little else is required for a brass-foundry equipment.

Character of metal bears an important part in the

brass-foundry, because bearings require to be homogeneous, of good resisting material to prevent abrasion, and hard enough to stand hard wear. Gunmetal, or phosphor bronze, bearings correctly cast, of good material, ensure long life to any machine.

Phosphor bronze is a favourite in light-bearing work for motor-car and like adaptations; but care in the preparation of the metal is necessary, otherwise such bearings often scale off, and rapidly deteriorate, besides setting up much frictional resistance. A good hard gunmetal, such as can be machined, is hard to beat as a bearing surface where a homogeneous metal is used. Such a bearing can generally be relied on, whereas phosphor bronze makes a doubtful mixture, and is hard to mix because the phosphor wastes enormously by flaring off, and it is hard to ensure that the whole cast will be of one quality.

Wastage of metal is a serious item in brass-foundry practice and needs careful and intelligent attention, because the material wasted is expensive. Such metal is easily wasted by too much heat. When melting copper much less heat is required than for iron, which takes nearly twice that of zinc, tin, or lead. The scum on a crucible of gunmetal is easily added to by unwise skimming when clearing the metal of dross; but this again is the province of those responsible for the production, and works management obviates pitfalls by employing the most skilled labour.

Quite a number of differences exist between iron and brass moulding, which only experience can meet and overcome. Brass or gunmetal castings need

quick pouring, therefore extra venting is necessary, or the cast will be destroyed.

To attempt to enumerate all that is necessary to watch in both iron and brass-founding would require many volumes; but the question of temperature is very important, and mere guesswork is sure to end in failure and waste. Various mixtures have different melting-points, or temperature range. Colour is a good indication of temperature, yet judging by colour is merely guessing, because it is hard for the eye to discriminate slight variations of colour, and where a few degrees will make all the difference between a bad and a good pour, care must be exercised to get the right heat.

General Considerations.—Thus far it is seen that whatever the up-to-date methods may be in works practice the human element is the guide and factor to success, and without it failure is sure to ensue.

Briefly, works management in foundry practice shines where a full appreciation of the value of expert operation results in profit. It is not so much knowledge that counts but judgment on the part of the organizer in using the best to get nearest the ideal at the least cost.

It will be noticed that nothing has been said of the stores. The reason is that on the proper equipment of the stores rests, to a great extent, the ability of the organizer to produce good paying results.

The stores will require very extended notice in due course consistent with its importance.

This brief outlining of departmental doings is merely intended to give the embryo management a

faint idea of the vast field to be covered ere hope of making a profit is possible.

By this time the reader will have got rid of the idea, if it ever existed, that works management needs hustling at a white heat.

Further it will be evident that mere strenuous energy is not always the best equipment for an organizer; in fact it is too often a sign of weakness. because the tactful organizer is one who knows rather by intuition than by simply watching operations and timing them.

Pattern-making and foundry production, in a sense, may be likened to the bar-production from the rolling mills, viz, rough preparation of raw materials from which the finished product will be evolved.

Both represent stage work performed on the crude material from which deleterious material has been removed, and in both the materials are given a form most suitable for the final end intended.

In many establishments drawings and patterns precede what is otherwise rough material, obtained outside: because many works purchase all castings from specialists engaged in that particular work, and very few firms provide the bar work used in their productions, in this case, as in foundry work, the iron and steel works are apart altogether from the engineering establishment.

This means that foundry castings and other material are often purchased from outside traders; therefore the engineering works require a buying department, and a place in which to store the material purchased.

It is just here where the real ability of an organizer begins to show, by works managing in such a way that complete control is held over both receiving and production. Such organizing involves buying the best at the cheapest price, and utilizing the purchases with the least loss, whilst producing the most excellent articles at the lowest cost, with the largest profit attached.

Thus what may be termed the starting-point in engineering production is reached.

The departments already reviewed require works managing to make them pay; but a general engineering works has been taken to simplify the examination of works practice, and obviously the remarks in respect to soap-making, pin manufacture, and engineering commence at this point, because soap-making or pin production does not commence until the crude material is provided; therefore works management directed to any particular production resolves itself into organizing to meet a satisfactory end, and embodies one set of principles incorporated into practice to suit the commodity produced.

As previously indicated the subject of store-keeping will be reserved to the last; because that is looked upon as the keystone to successful works organization which requires more than mere outlining.

CHAPTER V.

SMITH'S AND MACHINE-SHOPS.

A DISTINCTION is made between smith's and forge work; the latter is a special production of firms who are equipped to produce the best forgings at a reasonable cost; yet most smiths' shops of any size, if up to date, are provided with one or two power-hammers capable of dealing with sizes and weights by which the ordinary smith's methods would be taxed severely; besides two strikers or helpers are usual to reasonable sized forgings, and the larger work may only be occasional; therefore a steam-hammer will do what it would require many helpers to perform, and by its use the wages bill is kept within reasonable limits because no unnecessary strikers are required, and as large work is merely occasional, the steam-hammer is available to aid in its production, and it costs less to have a steam-hammer standing still than to employ several strikers who cannot be always fully employed.

Works management considers the conditions and provides for the contingencies with the minimum of loss; but to install a steam-hammer to meet a contingency that rarely arises, and where men are available from other fires, is simply spending money to no good purpose.

Forge work as indicated above need not be con-

sidered in this book, being outside the intention of its scope.

The smith's-shop is familiar to most, and the poet has thrown around it a romantic halo, which it deserves, because there is something weird yet marvellous about the brawny smith and his craft, whose being is set amongst great heat and flying sparks.

At first sight there is little need to do more than mention the smithing department, except for reasons that were well put by a well-known engineer of some eminence, now no more, who said, "On occasion, why waste time on a forging to bring it down to size when the machines can rip off the excess easily".

Unfortunately, this idea is too prevalent, and as it leads to somewhat serious losses it is too important to allow it to escape notice.

It is an axiom of good management that every department of a works should conform to dimension, and not leave to another the task of bearing the expense of faulty workmanship produced by the smith.

Leaving too much or too little on a forged article that has to be machined should be looked upon as a serious fault, and should be prevented, because to save a little expense in the smith's-shop may mean losing far more in the machine-shop.

Where the foremen of the smith's and machine-shop, in conjunction with the draughtsman, have agreed in regard to the design of any detail that can be economically dealt with, and will save time and expense, there is no excuse for disregarding dimensions to save a little time to the smith and penalizing the machine-shop to pay for the fault.

The drawings sent to the smith's-shop if correctly dimensioned should be adhered to.

To-day the necessity for accurate forgings has given rise to the production of drop-hammer forgings, leaving the minimum of material to finish off. This can only mean that ripping off material by machines is an expensive operation, and it should be avoided wherever possible.

Works management of a smith's-shop is materially aided when all departments are considered, and this is best attained by utilizing the most expert human element, and seeing that the most suitable sizes of metal are stocked to avoid unnecessary labour and waste. It is the old story over again, a bad workman with good tools is not economical, whereas a poor set of tools in the hands of a good workman may produce good results; a good organizer allows for good tools and employs the best men.

A full description of a smith's-shop is hardly necessary because it merely represents space occupied by hearths in which the material is heated, and these are served by a pipe conveying air under pressure to the fire by the tuyeres, and the air is supplied by a fan or blower driven from the factory engine. The forges, except a few parts, have a long life. Tuyeres wear out rapidly although protected by water circulating round them. Anvils, swaging blocks, swages, fullers, tongs, etc., complete the equipment.

Special cases require special tools, but the smith is generally able to make his own tools, thus saving outside profits.

Extended experience has shown that the addition of a steam-hammer facilitates production with some

advantage without adding to the cost of production.

The human element is an essential factor in the forging department, and under the guidance of an able foreman little serious trouble is likely to occur. An expert smith can easily deal with whatever difficulties crop up.

A few points may be of value as guides to a safe production of good forgings and little waste.

One chief factor is good material of suitable size which the expert smith will manipulate so as not to cut through the grain or lamination, besides seeing that, as nearly as possible, such lamination is placed in the best position of greatest strength.

Welding only needs a clear and clean fire, and care that when the necessary heat is reached the parts to be joined together are quite free of dross and scale. Sometimes the novice imagines that a fierce blow will force two pieces of metal together better than a few light blows. Light blows quickly applied, and increasing in force as the material cools can generally be relied upon to produce a sound weld, other things being attended to.

With care there need be little waste, and a few forming tools will save labour and ensure a clean job. The foreman smith, as an expert, and capable craftsmen, have it in their power to aid the management very materially in working to a profit.

Cheap material, merely because it is cheap, is after all only poor stuff, and failure will be courted assiduously if cheap material is always purchased. Buying the best material at the cheapest rate proves good

organizing. Scrap affords another means of saving; it should be sorted into divisions, because one class commands a higher price than another. But care is necessary, as too much sorting may swallow up any extra price obtained. The good organizer knows the limit and saves money.

Fuel is another means to economy. Paying a few shillings more per ton may mean pounds saved in a short time. Waste should not be allowed; it may arise from using too much, or using it carelessly.

Works management sometimes benefits by forcing the pace in a similar way that forgings suitably hammered increase in strength; but do what we like, or imagine all sorts of things, we must never ignore the human element, which is the end and front of all good management.

The space occupied by the smithy bears a share in the general indirect expenses, which must be carefully considered and is usually high; but the plant values are relatively small, and as a very rough estimate, which experience bears out, about 70 per cent added to wages will cover all indirect charges; very often less than this will do, but sometimes it is more; therefore 70 per cent is a safe rate.

The purpose of good organizing is to make the indirect expenses low, but the best plan is to run the works at full pressure, even if work is taken which will not carry the usual profit; yet the relative lowness of the indirect charges to the larger wages bill, will, if properly managed, produce a profit.

Summarizing the smith's-shop department, we see that few real difficulties will occur; at least none

that need cause serious loss, if a good guiding head is employed and he is backed up by expert craftsmen of known and approved ability.

One other point should be noted; charging the full weight of the material to the job direct covers wastage and leaves no chance of possible error, whereas weighing the finished forging and allowing for waste is to be deprecated, because the allowance may be too much or too little, even if it is not forgotten altogether.

Sometimes it is a wise practice to add a furnace and a large steam-hammer; this is often done by railway companies, who are thus able to utilize scrap to make faggoted billets from which large forgings can be produced at relatively cheap rates; besides, a few dies may result in economy where an article has to be repeated.

This is a case for the management to settle, and it can only be useful if it pays. If installed and it does not pay it is a wise policy to disband the addition, and obtain the articles required from an outside firm.

Presuming that castings and forgings are ready, the work of producing the finished machines can be proceeded with, and in general practice this is the actual commencement of the functions of works management.

Machining.—Perhaps the machine-shop, whilst being the most expensive, is the easiest of any department to the manager, and the one in which organizing becomes, more or less, a mere matter of supervision rather than calculation. Given a well-equipped machine-shop with plenty of work and ample power, the human element must be studied so

as to keep the machines constantly at work. A very common error is to gauge progress by the rate articles can be tooled, whereas the real limit rests with the man's capability to keep the machine at work as long as possible with the shortest intervals of setting and unsetting work. Very few exigencies need anticipation in the machine-shop, and probably no part of the works lends itself so easily to rule and rote, because few causes arise to disturb the rhythmic production.

To keep a machine running at its maximum speed of production the foreman has little else to do than keep the operator up to his work. Machining one class of article day by day takes all romance out of humanity, and as there is nothing to incite interest, or encourage attention—mere quantity will never do it—an indefatigable overseer is needed to keep up quantity of production.

All this is true, yet it is the most expensive department to install, and capital loss will occur unless the works management is fully alive to its importance. Plant wears out and its value depreciates, because its capability to produce decreases with age; therefore provision must be made to keep the original capital intact, whilst the revenue obtained is sufficient to pay interest and carry a profit.

The object of the organizer is to keep the machinery in good order to ensure the practical limit to be reached, though this costs money; but when a definite basis has been arrived at, the machine-shop need concern the works management very little, because it is not the most likely place for wastage.

The progress through departments will receive attention in due course, the present purpose being not so much installation of plant as the kind of plant employed, and its useful performance.

The plant comprises drilling machines of great variety, because some may be comparatively simple to suit small operations, whilst others, such as the swing arm, or radial type, may have to cover an extended surface. In some cases drilling machines have been made, and many are still in use, where the drill is carried by a traversing carriage having movement in both directions. Drilling machines are usually arranged together; this also applies to other classes of machines with some exceptions, such as machines convenient for erecting and fitting-shops. But good management means concentration, and that refers to every class of work; therefore, under good organizing, erecting-shop and fitting-shop drilling needs no standing machinery.

Lathes are another necessity, and these range from quite small to enormous sizes, according to the work to be done. Generally, lathe-work is of a straightforward nature, yet it requires ability which tells over a period of time. But strict attention is needed in a general engineering works, where turners are called upon to handle a variety of jobs requiring skill which is only obtained by experience; yet whatever the class, room is needed around each tool, and rents, rates, and taxes and other multifarious expenses must be met, whilst constant wear and tear necessitate repairs, and plant value as depreciated must be recoverable from revenue before any question of profit can be hoped for.

Planing machines, milling machines, screwing machines, boring, and such-like must be installed, and as with the lathes and drilling machines they cost money to keep going, and lose value as time goes on.

Lifting tackle is very needful where heavy articles have to be taken in and out of machines; but money is easily lost by a too lavish employment of expensive cranes, or travelling gantries.

The idea is too prevalent that a works well equipped with lifting tackle means an up-to-date paying concern, whereas it may be the cause of considerable loss.

The sight of a 10-ton traveller conveying an article which one or two men could easily carry, at far less cost, is nerve racking to the economical soul of the organizer: but on the other hand, that of a body of men painfully struggling with a lump of a machine, and getting in each other's way in the earnest desire to help progress shows bad management, and no sense of organizing.

In such a case the 10-ton traveller would be fitted if such lumps required moving frequently, and this would prove that the organizer was alive to the necessity.

But to install a 10-ton crane for the purpose of moving a heavy weight once or twice a year, and filling in its time by doing what a couple of labouring men could do easily is not only absurd but wicked.

The labouring men are required under all circumstances, and where a few hours of time are covered by a few shillings for the men, the use of the travellers may mean pounds. It is the province of works

management to avoid such mistaken policies, and save wastage of money.

Power is an important factor in works plant, and it must be remembered that an engine developing a small power represents much waste of power, whereas the same engine giving out a much greater power is less wasteful; therefore running under full load is economical, and necessitates that machines shall be kept up to their practical limit of speed.

These matters bring in some of the main qualities of an organizer, and prove the wisdom of good works management, and their recognition needs careful and extended attention.

Starting with the power member, whose ability to perform work is penalized by the energy required to keep it going, which may mean 10 to 30 per cent of the developed horse-power, it is seen that loss occurs initially; but such loss is variable according to conditions; therefore sound organization makes allowance for the variation.

For this reason organization cannot be inflexible, yet it may be so flexible as to be a cause of serious loss.

The power developed by the engine needs distributing over a wide area, and the method of such distribution gives rise to untold discussion, which is bound up with either fancy or self-interest to such an extent as to make one method appear to be superior to another, whereas there may be little to choose between them.

Many advocate the breaking up of power into sections by using small engines to dominate various

sections of a works, and such claim advantages which are real in themselves; but they cannot be claimed except by isolating the advantages and ignoring the disadvantages.

There is no intention of entering fully into controversial fields here; but it must be asserted with as much enthusiasm as possible that large powers are far more economical than small ones. Suppose 200 h.p. is required, and it is installed as one element, and suppose the efficiency is 84 per cent, the loss is 32 h.p.: but with the power divided into eight elements the efficiency is probably 70 per cent, and the loss is 60 h.p., or nearly double that of the single element.

Whilst there is no intention of traversing contentious ground, yet something must be said to furnish a reason for breaking up the one element into eight. Shafting and belts are required to reach the location of the various machines, and these lose power by slippage of belts and friction of bearings; therefore the advocates of the distributed power argue that where a distant section is required to work whilst the others are standing there must be a saving of power for the one section dominated by one distributed element. Now either the distributed elements must, in the case of steam engines, either take steam from one central steam-making plant, or have its own separate producer.

Hardly any engineer, except under very exceptional circumstances, would argue for a divided steam-producing plant, because steam loses value when supplied at a distance from the point where it is generated, in spite of clothed pipes.

Others strongly advocate the use of distributed electrically driven elements, and claim an enormous saving.

However power is provided, the original loss due to inefficiency is inevitable, and of the 100 per cent efficiency, the electrical element of power probably loses 5 per cent, and before the element gives out its power effect another 5 per cent is easily lost; thus 10 per cent certainly is lost at the source, beyond what the engine loses for generating the electricity.

There can be no doubt that enormous waste of power occurs with the belts and shafting. In one particular case the writer was consulted as to new power required for a large works, after the large engine had been thoroughly overhauled, because it proved to be inadequate to the work required.

The indicator applied during sectional shafting tests revealed a state of things that were alarming. An underground shaft took so much of the power that little was left for useful driving. When this shafting was put in order no question of new power arose, even when the driven plant was added to considerably. That was an object lesson learnt by experience, but other cases occurred where loss of power at some distance from the engine was exceedingly little.

Under good works management where the running plant is kept in good order, and all belts are cleaned thoroughly and kept pliable, it is easy to save, say, from 15 to 20 per cent of wasted power. This is true even where centres of shafting for heavy drives are abnormally close. Many cases could be cited where the exercise of reasonable common sense resulted in an enormous reduction of lost power.

Generally, large powers can be used more economically than small powers, and with good judgment, and at little money cost, distribution of power by shafts and belts can be carried out with the minimum of loss.

Molesworth gives 1 h.p. absorbed for every 100 feet of shafting run at 120 revolutions per minute—equal to a surface speed of, say, 10 feet per minute; but in really good practice probably less than ½ h.p. would be sufficient to allow.

Much practical good may be ensured by the works management where a few sensible rules are observed.

Wherever a heavy drive is needed pulleys should be placed close to a bearing, and belts should be wide enough, and slack enough, to drive without putting them to unnecessary tension. The belt drives by frictional resistance, and as the coefficient generally used is ·3, anything that will increase the adhesion adds to the life of the belt by reducing the tension required to get the result.

Single belts pull better relatively than double, the double belt transmitting only 1·6 times as much power as the single. A broad single belt on a large pulley run at a high speed and kept pliable is the best condition to get an economical result, and where a single belt is not strong enough, another single belt run on top of it will do the work with both belts working comparatively slack. Experience proves that such a drive is safe, gives little trouble, and will run without attention for a long time. Flexibility is the life of a belt; besides it adds to the power effect without adding to the disadvantages. The writer was compelled to use a drive with close centres, and to get

the power required used an 11-inch double belt, which was always breaking and caused endless trouble. A link belt of the same width was run on the top of the other, and both belts were left "wobbly slack," yet the drive was perfect; all trouble ceased, and the belts did not appear to suffer in the least, though they delivered 40 h.p.

All driving belts should be taken off and straightened out and the surfaces thoroughly scraped and washed; afterwards a good coating of castor oil must be allowed to soak in. This will increase their driving power, and add to their life; besides, the cost is little and money is saved.

Suppose a belt under ordinary careless conditions suffers 33 per cent depreciation, under such methods as outlined the depreciation will easily fall to 15 or 20 per cent. Belts are costly, and supposing the yearly outlay is £100, the first year the value is reduced to £66 for ordinary conditions, but under attention the reduction is say to £80, or £14 saved.

Suppose twelve men spend six hours four times in the year to attend to the cleanliness of belts, and including oil, etc., the cost per annum will be less than £7; therefore £7 per annum is saved, and the life is increased fully one-third, representing £33 saved in material; besides, and this is more important, power is saved, and it can easily be proved that care and attention to belts and shafting may easily mean many hundreds of pounds saved per annum, and that spells profit by good works management. These are facts and not fancies, therefore all who are responsible for running plants should attend to such a method of saving money.

In this connection we will mention two other rough sets of factors of great value when installing shafting.

1. The best distance from centre to centre of bearings for 2-inch shafting is 8 feet, 2½ inches 10 feet, and 3 inches diameter 12 feet; no pulley should be placed in the centre between bearings, that is for a main drive.

2. The distance between shafts is largely influenced by size of pulley and speed; but, generally, 6 to 10 diameters of pulley is good practice, and where pulleys of different diameters are used the largest must be taken. In all cases the faces of pulleys should be slightly rounded, and the belt should be made as nearly as possible of even thickness throughout; this means a careful butt joint, which is the best.

Where two shafts are not parallel it is surprising how much angle may be permitted if the crowns of the pulleys are rounded sufficiently to meet it. A good plan is to face each pulley to the crown at an angle with the side equal to that of the two shafts, and make both sides alike but opposite angles; then round off the centre. The writer has driven two shafts successfully where the angle was as much as 1 inch to the foot, and never had any trouble.

Practically the same principle is adopted in the case of jockey pulleys, acting as a connexion between two shafts lying in different planes, and placed at very acute angles to each other. All these things are points indicative of the many ways in which management may save money.

Now, engines, boilers, shafting, and belts, or other driving gear, represent sunk capital which must be recovered over a time by a tax on revenue, and this

is generally met by allowing a percentage on the capital value represented by the plant. This brings in depreciation and upkeep of plant, etc.; but before dealing with such important factors, finishing and erecting-shops require some attention, because probably these shops are the places where final profit or loss is made; therefore they require extended notice.

CHAPTER VI.

FITTING AND ERECTING-SHOPS AND THEIR MANAGEMENT.

THE fitting-shop plays an important part in all engineering work, and its success relies more on the human element than any other department in which production is proceeding. Time is easily wasted and money squandered in attempting to remedy what the machine-shop has neglected in their haste to produce rapidly. Hustling a job through to save a few shillings in the machine-shop, only to waste much more money in the fitting-shop, is both bad organizing and improper practice. One frequent cause of waste arises where planed surfaces are intended to be level and bright, such as a lathe bed or large surface plate. Before these are taken off the machine a long straight edge and three parallel strips will show whether the surface is true or not when the holding down dogs are loosened, whilst straight edges placed across the ends and sighted or gauged from the planing machine table will test the winding. If found inaccurate a light cut with a broad tool, with the job lightly dogged down, may cost a few shillings, whereas with a badly warped surface it would readily cost many pounds to remedy the inaccuracy in the fitting-shop.

A planed surface, broad tooled and flat, will look

well when rubbed down with emery paper and oil, whereas a twisted surface, after much time is spent in remedying the fault of the machine-shop, will look like a scamped job with tool-marks showing here and there, and before such tool-marks are got rid of money is lavishly wasted, and trying to please the customer ruins the producer.

Where the contract guarantee is for a bright, smooth, polished surface, free from tool-marks and flat, good planing is essential, and getting up will cost the minimum of labour, whereas a badly planed surface entails much labour of the human element at a costly rate.

In all cases for machined surfaces the cheapest way to produce is by machining carefully. Many similar cases could be cited, but enough has been said to show that organizing to a successful issue allows latitude for contingencies, and makes provision to meet them.

Where any case is doubtful the machine and fitting-shop foremen should confer together, and where doubt still remains the manager is the person to determine the best thing to be done.

Sometimes, though rarely, pins will not fit the holes they are intended for, and fitters' time is wasted in doing over a long time what the turner could have done without wasting time; but few of such evils would live long under good management. The idea is too prevalent, though few would acknowledge it, that the fitting-shop is a convenient place in which to remedy the errors of other departments; but under capable management such ideas quickly evaporate. Each department must do what

is expected of it, and only in exceptional cases should the rule be relaxed; but the manager must be the man to prescribe the limit.

The fitting-shop is for the purpose of doing what the machine-shop cannot; or rather doing something cheaply which would cost much in the machine-shop. Much discrimination is needed, but a good organizer will see that every department performs the duty intended, and prevent the re-occurrence if it ever takes place.

For convenience a drilling machine and a lathe are generally installed in the fitting-shop, or are placed handy to it; but their necessity shows that there is a lack of accuracy allowed which the good organizer would discount, because it means losing money by doing in two operations that which should be done in one.

Generally speaking, the fitting-shop deals with what can be man-handled, therefore no lifting tackle is needed; so a bench, vice, and a drawer full of tools, and a handy small tool store make up the equipment of the fitting-shop, of course including the man, whose experience is valuable and that should be appreciated at its worth.

As a department like the fitting-shop takes up space it must bear a proportionate share of indirect expenses. The principal item of expenditure is files, and these wear out so fast as to have no yearly life, and used files, however good at stocktaking, should never be valued at more than one-third of their original cost. The expense attached to the fitting-bench, including files and other wearable tools, does not amount to much per man, yet their capital value must be considered;

but screw taps and other general tools depreciate quickly; besides, the fitting-shop represents a given space occupied per man which must pay rent, rates, and taxes, light, and many other incidental charges. Percentage on wages covers working expenses, as in other departments, but such percentage may vary enormously according to the class of work. Light work always carries a heavier percentage for working expenses than the more weighty.

When dealing with the human element much tact and judgment is needed, because it varies more than any other part of an engineering business. In spite of the apparently simple character of the fitting-shop careful supervision is required, because it is there that profit may be assured, or serious losses may be entailed.

Judgment of men by casual observation is bad, because one day a man may be at his maximum-producing power, and on another at his minimum; therefore an average must be struck, and that is best done on the week's output.

The pernicious habit of piling work up before a man is to be deprecated, because it discourages him, and reduces his energy. On the other hand, too little causes him to lag. He must be fed with work consistently, and under no circumstances should too much finished work be allowed to remain. There should be just enough work before the man so that the foreman can take stock of it by a glance, and the same for finished work, the object in all cases being to take in at a glance the rate of progress.

Many workmen like plenty of unfinished and finished work before them, because it is hard for the

foreman to gauge a rate; thus it encourages laziness and must not be allowed.

The following statement may be considered, and attention to it saves money, especially where complete small machines are produced at the fitting-bench —Never put a part together that must come apart to insert a lacking item, because time is lost in taking to pieces. When such occurs it indicates bad management in allowing a detail to come first that should only come second, and this is one of the ways a good organizer can save money, by producing, in sequence, as required.

The fitting-shop is also the place for finishing off the lighter details, after the complete machine has been assembled or erected. This finishing can easily eat up money; therefore it must be carefully and consistently watched. Many a detail, in expert hands, will assume a presentable appearance and cost little, but the same detail may have much time and labour expended upon it and after all be unsatisfactory to the eye. A good axiom is to finish what the eye can command and no more.

The writer learnt this lesson early in life when busy facing up the flanges and raised connexions of an engine bed-plate. The proprietor, a splendid engineer and a keen business man, said: "Come out here and say if you can see the two sides at once". I could not, and the lesson was driven home, and ever since the maxim "finish to please the eye" has been of service, and it will ever be good when finishing off an engine or machine—of course only with parts that perform no function other than as a base.

All working parts must be of the best, and ac-

curate work in the machine-shop with bearings and journals saves much money during erection.

The works management knows that the acceptance of a machine or engine rests upon the capability of performing the work intended, and unless it does that at the start, profit disappears rapidly.

Many things are done during erection which could be done by machinery, but the expense is prohibitive. The management compromise matters by insisting on machine accuracy, and gives latitude to the erectors to meet slight variation, which inevitably occurs no matter how perfect the machine plant may be. With every care used in producing machine tools it is impossible to reach perfection; therefore inaccuracies will occur, and must be met by anticipation and overcome by what practical possibility teaches.

No good purpose can be served by extending the references to very obvious matters connected with general engineering; a reference back to what has already been outlined shows the magnitude of the field that works management must traverse to obtain the desired result.

Estimating, financing, drawing, founding, pattern-making, machining, fitting, erecting, and finishing are merely groups within which innumerable details bristle with difficulty and in many cases are hard to bring to a successful issue; but the groundwork of general principles has been laid on which successful works management must be built.

During the Manchester Exhibition, whilst admiring one of the many machines exhibited, a stranger ejaculated: "It is marvellous to think how the mind

of man can grasp so much detail and produce such a wonderful machine ".

When it was pointed out to him that the complete machine was really the aggregation of a number of details, the simplicity of the arrangement charmed him.

Tracing one thread along its course from commencement to finish gave a complete idea of the process produced by the gathering together of parts. The multiplication of such complete parts made up the whole machine, with the threads lying side by side—rough at the start but highly finished and glazed at the other, reeled, ready for use.

To the works manager the huge machine of commerce is the aggregation of similar combined details, and their amalgamation to produce a paying and useful result is the purpose of his life. Thus to the skilful organizer, one department is very like another, and with the material ready to his hand, each must produce its share in the general output.

It seems simple, after the explanation, but the magnitude is what staggers the beholder, and the enormous nature of the work works management tackles staggers the embryo manager by its multiplicity and vastness.

Stores.—One very important, even if not the most important department, in any engineering works is the stores.

At first sight it is difficult to see in what way the stores can be of use to the various departments, especially to the drawing, pattern-making, and foundry.

A little consideration brings a gleam of intelligence

when we remember that the range of departmental sections of the complete works represents the combination of parts to produce one complete result, whilst the complete machine, being the total output, is that on which revenue depends.

It may be rather a startling assertion to say that the complete works is one large store, and that the ordinary stores is merely a miniature of the larger, even as a key is the essential dominator of the greater lock.

In some up-to-date offices associated with railways, tramways, and even mines, there is a miniature plan on which every section of an extensive system is seen at a glance, every detail being relative to some other. The stores should be such a miniature, enabling the governing hand to control the larger system by actual sight, and successful works management is ensured where a complete and active control is centred in the capable hands of one man, who knows how to guide a variable set of forces into one channel to obtain a desired result.

The ideal conception of what a works of any class should be is that in which crude material enters at one end and leaves at the other, combined and complete, as a satisfactory production, the stages of progress being clearly defined and arranged without the possibility of going wrong. Many attempts have been made to attain the ideal, and some specialists have gone so far as to claim perfection; this is especially true of American exploiters to which some attention will be given in due course.

The practical exponent does not deride the ideal conception, though he does deprecate attempts that

always fail; because the ideal has no existence except in the imagination; the writer is dealing with possible things, and in doing so asserts strongly that fostering ideal systems to deal with non-ideal realities is leading many foolish ones astray, not only to their own detriment, but to the peril of national well-being.

Fluctuations of volume of trade, differences in the price of materials, alteration of bank rates and bills of exchange, coupled with untold exigencies that occur day by day in a works producing articles from materials that may develop faults at any moment, are in no sense ideal conditions to be governed by an ideal system.

Where production proceeds on uncertain and variable lines progress can only be aided by methods of a give-and-take character, which assumes some elasticity, but that does not necessarily mean looseness.

To attempt to control a large works by getting all the line together into one hand is beyond human capability; yet it is possible to control a miniature works, because it enables the hand to control all the lines, and the stores can be made the miniature model that will exert an influence on the works proper to direct its operations as the mind of management desires.

The captain of the giant ocean leviathan does not touch the wheel, yet it is he who guides the ship and brings her safely into port. What he does is to use the powers available under his direction, and that is what the works manager must do if he wants the safe conveyance of valuable products to reach their journey's end with satisfaction to every one.

To say that the steering wheel is the ship would be absurd, but small as it is, it controls the ship's movements, and, small as the stores may be, they should control the immense works at the command of management.

Between the steersman's hands and the rudder suitable powers are arranged, quite capable of directing the way the giant ship must take, in spite of buffeting waves and boisterous winds, but to lay down a strict law that a given movement of the wheel will cause the ship to change her direction a defined amount, because such movement of the wheel and ship bear a close proportion to each other for ideal conditions, is senseless and opposed to facts that occur every day.

Rough seas and smooth seas, head or bow winds, whether weak or heavy, make all the difference in the distance the steering wheel is moved to change the ship's direction a defined amount, and only experience knows how much.

The captain of the ship gives a course which the steersman keeps, and under ordinary circumstances the captain does not interfere ; but when he does his commands are immediately obeyed, because the steersman believes in him.

All this may seem to be unnecessary in a work of this description, but long experience has shown that bad captains are often disobeyed, or the ship of the works would soon be on the rocks. Where the command is backed up by the power behind the captain, although the command is strong the ship may lose way, time is lost, and money wasted.

But given a captain who is trusted, because his

ability to govern has been proved, his commands are obeyed at once, and good way is made and money is saved.

Yes, what the steering wheel is to the big ship, so is the stores to the works it should control under the commander's direction.

In this sense the stores is the works because the stores in miniature repeats what the works does. The works as a whole is lost to the control of one man direct; but through a properly equipped stores active control is possible even over elements that are distant.

The statement that organizing an engineering works really commences when castings are looked upon as crude material, supposes a storage for such articles. If castings are obtained outside of the works they come under the province of the buying department, which is one of the agencies a wise management employs; therefore castings must be included in the management's methods. In fact everything, from the getting of the crude ore to the completion of the machine or engine, requires works managing. The production of the ore by mining includes so many special factors so as to make the mining industry one by itself.

The production of pig metal from the ore is within the province of the smelter, and is another trade by itself.

The manufacture of bar iron and steel is apart from engineering proper, yet each of these as producing factors requires works managing, but the principles governing one govern all; therefore specialization of a detail needs as much organizing ability as the

gathering together of details into one complete apparatus.

Such principles brought into practice require different valuations, but the end and front of them all is profit, or pounds, shillings, and pence; therefore works management by valuing correctly uses the knowledge to the best advantage.

Therefore, be it running blast furnace production, iron and steel manufacture, steam-engine making, or soap production, the underlying principles are the same.

With the material already supplied, and an outlined knowledge of the expansive character of the subject, its utilization to a practical end may be examined.

The following is based upon actual experience in the production of a profitable result.

CHAPTER VII.

THE IMPORTANCE OF STORES IN ORGANIZATION, ETC.

It is an unfortunate fact that many firms, whose businesses are looked upon as being amongst the best systematized in the world, find a great difficulty in utilizing their capital to the best advantage, and the reason can only be due to systematizing on lines that are unsuited; in fact, whilst the systems are presumedly perfect, the organization is bad in every sense, because system is permitted to degenerate into the worst of all faults—red tape.

Such systems are admirable, and in many ways ideal, but as there is no such thing as an ideal business there is no necessity for an ideal system.

People talk learnedly of systematizing and standardizing, and innumerable treatises foster the idea that system, if properly carried out, means enhanced profits; whereas to many it is the high road to the bankruptcy court, and spells eventual failure. Systems presuppose rhythmic order, due to regularity of operations, and such are assiduously exploited, and gain many disciples, who find out, when too late, that they have been nursing an impossibility. Every engineer knows that of the numerous sources of power at his command, only a small percentage can

be usefully employed, and even that is subjected to so many contingent happenings as to make its realization a matter of doubtful certainty.

This is true in every department of life, and is especially true in production, therefore works managing is beset with difficulties; but good organizing makes possible what is otherwise likely to be a source of loss and wasted energy.

Works management is required on the commercial as well as on the producing side of any business, but the present object is with production, or the works, merely to save complication and to narrow the field of exploration.

Three divisions are assumed for production, based on the assumption that plenty of orders are on hand, and of full market value, which includes a profit to the producer, if the work is carried out under good organizing.

Getting the work in hand quickly is the first purpose, because much money may be muddled away at this stage. How much few seem to know, but the experienced practitioner knows that the costs of starting a job may seriously handicap future prospects of profit-making.

The second stage of progress—machining—is comparatively a simple one after the necessary tools have been installed, power provided, and the limit capacity of the machines known. After these have been attended to and the work is ready to be attacked, supervision for quantity and examination for quality are all that are required to ensure that the machine department will produce cheaply.

On the other hand, the dead or indirect expenses

of the department may be so heavy that mistakes become costly.

The third division is finishing, which includes fitting and erecting, and as there is no possibility of recouping loss after this stage, it becomes the important factor in production—requiring care, ability, judgment, and vast experience.

These three broad divisions represent the carrying capacity of the works, and the stores should be the steering wheel to guide the whole fabric to a successful issue.

The axiom is that everything is taken from stock and all things are returned to stock, though the stores may be, relatively, but a small place compared with the expanse of works.

The stores must be the custodian of all crude and finished material, be it a steamship, locomotive, watch, or a mere pin. In this sense the whole establishment is the stores, of which the stores proper holds the equipment to act as the guiding power of the whole organization.

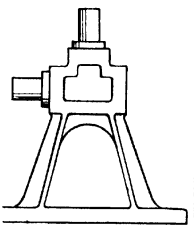
Storekeeping means keeping a faithful record of all stock, the stages of its progress, and its finished condition. This needs a man of special capabilities, drawn from the source from which foremen are found. He must be technically trained, and have good sound and simple clerical abilities. The idea that a respectable, intelligent labourer is good enough to manage the stores is an indication of a misconception of the importance of storekeeping.

The right kind of storekeeping need not involve much labour after it is properly organized, though every article contained in the works, being part of

production, is provided with a label which gives a sight-glance of the in and out of store conditions, and subtracting the out from the in actual stock is known. The *in* side of the label shows the quantity at last stocktaking, plus any ordered since.

A specimen label is as follows :—

STORES NO. 800.



DRAWING 50A BRASS CASTINGS

Quantity last stocktaking (50)

IN		OUT		
50	last stocktaking	5 June	Order 10—	5
50	ordered 6 June	,,	,, 12—	3
6	received 24 June	,,	,, 8—	1
8	,, 5 July	,,	,, 30—	7
36	,, 6 July	,,	,, 34—	4
		,,	,, 47—16	

The *out* column shows that 36 were given out, leaving 14 in stock, and 50 being usual stock, another 50 were ordered by requisition from storekeeper to manager.

All this is seen at a glance as recorded on the label. The storekeeper's requisition for renewal of stock is sent to the manager each day if necessary, and the manager, according to his discretion, sends it out direct, or through the buyer's office, if such exists. For the case as cited above, the following is given as an example :—

Stores Requisition. Date, 6th *June*, 1910. *No.*
Brass castings required for stock, as Drawing 50A.

Note.—50 should always be stocked, and after supplying as required only 14 remain.

Number required, 50; because others will be needed for current orders at an early date.

Storekeeper—JOHN JONES.

Such an order, whether sent to the firm's brass-foundry or to an outside firm, contains the request for delivery before the end of July.

The requisition must give the price of the castings, which is generally an average rate.

On receipt of the castings the storekeeper signs for them, and enters their complete delivery in his inwards day book. Thus he must be able to testify to the quality of the articles received, and keep a true record of all transactions. But as shown, the times and numbers as received are recorded on the label.

Such an example is applicable to all stock which needs no elaborate system of book-keeping of checks and tallies.

But another label may be as follows, either for work in progress or for finished machines.

For the finished machine the example label is sufficient:—

STORES NUMBER 960

Here give particulars of class and number of job, etc., for reference.	Drawing 51A	Drilling Machines
	IN	OUT
9 *machines*	Received 3 8 Aug. ,, 3 10 ,, ,, 3 15 ,,	Sent off 3 9 Aug. ,, 3 11 ,, ,, 3 16 ,,

Order completed 16 August, 1910.

Storekeeper—JOHN JONES.

The storekeeper knows that the order is complete because he is provided with a list of current orders giving date of commencement and when to be delivered.

As each complete machine is notified to the storekeeper as complete he notifies the manager who either examines the machine or orders others to do so before they are sent out. This is generally done before the storekeeper has the finished article sent to him. As a fact such a machine never entered the stores, yet any official can see the progress at a glance by a walk through the stores.

Directly the machines are passed as complete they are transferred from the producing to the commercial account, though the machines have been sent off to their respective owners.

But many articles are sent out from the stores as a rough detail and returned as finished. They will not be returned to the store until they are complete; yet each stage of progress as completed is notified in writing to the storekeeper who records it on the label, referring to it as follows :—

STORES NO. 760

Drawing 52A.—Brass Castings. Quantity last stocktaking (50)			Planing	Shaping	Boring	Turning	Milling	Drilling	Smith	Finishing
In	Out									
50	Order 10, 28 July,	5	5	5	5	5	—	5	—	5
	,, 6, 29 ,,	3	3	3	3	3	—	3	—	3
	,, 8, 3 Aug.	1	1	1	1	1	—	1	—	1
	,, 30, 10 ,,	7	7	7	7	7	—	7	—	7
	,, 35, ,, ,,	4	4	4	4	4	—	4	—	4
	,, 47, ,, ,,	6	6	6	6	6	—	—	—	—
	,, 51, ,, ,,	10	10	10	10	10	—	—	—	—

A glance shows that twenty are finished and all operations except drilling are complete, but sixteen remain unfinished. The information is supplied to the foreman in charge of the machines where the stoppage occurs, and as each foreman gives the storekeeper information of the completion of each operation, a perfect sight-check on progress is shown by the label.

Perhaps, without inquiry, the manager sees that a delay occurs at the drilling, and a visit to the machines show them swamped with work because they are unable to cope with the demand.

One or more new machines get rid of the congestion, so progress is not barred.

Under such a system of organizing officials walking through the stores see at a glance what progress is being made without troubling any one with questions. This is a method of organizing the stores to ensure a good result which does away with memorizing or elaborate progress sheets that take time and money to produce.

Quite enough has been said to enable any intelligent manager to organize a stores on the principle of permitting a sight-view of progress at any time.

The duplication of the schedules to the manager, already referred to, allows one to be handed to the storekeeper which he returns to the manager with the quantities marked that can be supplied from stock required for the particular job, also notifying the number remaining, and the number usually stocked.

The manager orders what the stores cannot supply, and he replenishes stock to the quantity usually kept. Thus no delay occurs, and work is got into

The storekeeper knows that the order is complete because he is provided with a list of current orders giving date of commencement and when to be delivered.

As each complete machine is notified to the storekeeper as complete he notifies the manager who either examines the machine or orders others to do so before they are sent out. This is generally done before the storekeeper has the finished article sent to him. As a fact such a machine never entered the stores, yet any official can see the progress at a glance by a walk through the stores.

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	,, 6, 29 ,,	3	3	3	3	3	—	3	—	3
	,, 8, 3 Aug.	1	1	1	1	1	—	1	—	1
	,, 30, 10 ,,	7	7	7	7	7	—	7	—	7
	,, 35, ,, ,,	4	4	4	4	4	—	4	—	4
	,, 47, ,, ,,	6	6	6	6	6	—	—	—	—
	,, 51, ,, ,,	10	10	10	10	10	—	—	—	—

Some so-called perfect systems insist upon cards as a handy means of reference; but even where the best card system is in vogue the well-proved method of job-pricing all work should be carried out, because it provides important information in book form that is not so likely to be lost as a card may be.

The old name for such a book is "Prime cost," in which all classes of material and operations and the value or cost expended on them is set down to each job under its particular number. It need not be kept in regard to all that affects the details, or that is referred to a folio of the old-style "Journal". Such books should be open to the official staff for reference when needed, and it should be an axiom of every business that the one responsible for works management should have free access to all books; otherwise something of importance might be lost to his calculations.

Works management commences with the estimation of price and continues right up to the final delivery into the customer's hands. Tying the hands of an organizer by keeping something from him is bad policy and will only lead to loss, because every expense, from whatever cause, must be included in works management, and no profit can be declared until every other expense has been met.

Sometimes the absurdity of restricting the field of action of the organizer reaches to the drawing office and costing departments, and to such foolish practice the very variable estimates recorded in the public journals for one contract may be responsible, and would probably be avoided where works management is responsible to one organizer.

A good practice is to assume that the whole time occupied shall be charged to a job direct, but the rule must be sufficiently elastic to meet the frequent occasions when such charging becomes impossible as a direct charge.

The proper organizing of the stores is highly important, but it is only one part of a very complicated concern. Stores methods, as outlined, cannot ensure a profit, but other things being equal, the method is a good way of guiding orders to a profitable end.

The stores arrangement is what may be termed the right way to keep a grasp of visible effects; but more than this is needed, such as what may be termed the invisible factor of indirect expense, which involves so many items that cost money and must be accounted for, that neglect or oversight in regard to one part will lead to failure and disaster, unless intercepted and provided for.

Valuation brings in capital investments, and capital is the essence of all successful business and must be kept intact under every condition, good or bad.

The subject of valuation refers to land, buildings, plant, tools, and many other contingent factors that are included in the capital account.

A very common practice is to write off the cost of all repairs, etc., at the end of the financial year. That cannot be commended, although accountants declare it to be the right course to pursue. Thus the start of valuing a concern brings in a contentious element, but as this work is for embryo or officiating works managers, the case must be met by a practical illustration.

In all businesses a purchase book is necessary, and

by taking one or more items from it an object lesson is set; for example:—

No. 1, 8 June, 1900, refers to a gas engine as follows:—

Gas Engine. One 8 h.p. No. 3786a.

Makers—Wilkinson & Son, Salford.

Magneto ignition, side shaft driven by spiral gear, and engine fitted with latest improvements.

Price	£98	0	0	net
Foundation, concrete bed, bolts, plates, etc.	2	15	0	,,
Pipes and fittings	7	15	0	,,
Fixing	12	7	0	,,
Total	£120	17	0	net
During April, 1904, a general overhaul was made, and new piston rings, etc., were fitted at a cost of	£6	10	0	
And on 7 December, 1905, grinding in valves, etc., cost	1	10	0	
The capital value was depreciated over five years, but it was increased by work done equal to	8	0	0	

Making a total expenditure of £128 17s. 0d., and suppose the capital value was depreciated over five years, equal to, say £8 0s. 0d.

These repairs were necessary to bring the engine into full service; without them the engine would have been useless. Thus the expenditure of £8 increased the depreciated value; besides it reinstated the power, that would otherwise have been lost. The valuation of this plant at various dates is referred to later.

Another example is a planing machine, as follows:—

No. 2. Planing Machine.

20 July, 1900.

Makers—Spingle & Co., Halifax.

To plane 8 ft. × 3 ft. × 3 ft. One tool box, self-acting in the horizontal, vertical, and angular cuts.

Table 9 ft. × 28 in. Rack and pinion driving motion. Quick return.

	£	s	d	
A strong machine	£100	0	0	net
Two table vices, screw action, width of jaws 6 in. to open 12 in.	5	0	0	,,
Countershaft complete	4	1	7	,,
One pair of guide pulleys, brackets, bolts, etc.	6	0	0	,,
Fixing	4	4	6	,,
Total . .	£119	6	1	
General repair, 16 July, 1904 . . ,,	£4	10	0	

The result is as the previous case.

Another example is a lathe :—

No. 3. Lathe, 10 in. centres.

One 10 in. centre, self-acting, sliding, surfacing, and screw-cutting lathe, to admit 7 ft. 6 in. between centres.

Gap to take 40 in. × 15 in.

Bed 12 ft. long. Double geared headstock with machine-cut teeth ; steel spindle and gunmetal bearings ; double clamp nut for leading screw ; quick return by rack and pinion (hand).

Traversing stay ; 22 change wheels ; carrier chuck and face plate, and countershaft, a strong tool . . £75 0 0 net

Face plate, 36 in.	1	15	0	,,
Fixing, including materials	9	18	6	,,
One dog chuck, 18 in., 4 jaws . . .	4	18	6	,,
One mandril stand	1	10	0	,,
Total . .	£93	2	0	
Repair, various, 8 Nov., 1904 } ,, ,, 18 Nov., ,, } . . .	£3	5	0	

The result is as in the first case.

These examples are sufficient to show how plant valuation and depreciation may be arranged for annual consideration.

Writing off repairs, etc., annually, in the opinion of the writer, is unsound, because it writes off a value that increases the life of a machine.

by taking one or more items from it an object lesson is set; for example:—

No. 1, 8 June, 1900, refers to a gas engine as follows:—

Gas Engine. One 8 h.p. No. 3786a.

Makers—Wilkinson & Son, Salford.

Magneto ignition, side shaft driven by spiral gear, and engine fitted with latest improvements.

Price	£98	0	0	net
Foundation, concrete bed, bolts, plates, etc.	2	15	0	,,
Pipes and fittings	7	15	0	,,
Fixing	12	7	0	,,
Total	£120	17	0	net
During April, 1904, a general overhaul was made, and new piston rings, etc., were fitted at a cost of	£6	10	0	
And on 7 December, 1905, grinding in valves, etc., cost	1	10	0	
The capital value was depreciated over five years, but it was increased by work done equal to	8	0	0	

Making a total expenditure of £128 17s. 0d., and suppose the capital value was depreciated over five years, equal to, say £8 0s. 0d.

These repairs were necessary to bring the engine into full service; without them the engine would have been useless. Thus the expenditure of £8 increased the depreciated value; besides it reinstated the power, that would otherwise have been lost. The valuation of this plant at various dates is referred to later.

Another example is a planing machine, as follows:—

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assumes that all repairs are added to depreciated value, which increases the general valuation by that amount, being capital sunk to produce a result that would otherwise have no existence.

The method suggested, and which experience has proved to be of great value, is set out in the following tabulated form. This is part of the work of the organizer, because on it rests the means to be employed to get the correct value of the indirect expenses to enable the proper percentage to be found that, when added to wages, will cover what are called dead expenses.

Example of how annual valuation is determined.

No. 1. GAS ENGINE.

	1900	1901	1904	1908	1912
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Valuation .	120 17 0	108 15 4	79 4 9	51 16 5	32 12 3
Depreciation 12½ per cent	12 1 8	10 17 6	7 18 5	5 3 8	3 5 2
Net Value .	108 15 4	97 17 10	71 15 4	45 12 9	29 7 1
Additions .	—	—	—	—	—
Repairs .	—	—	—	—	24 10 0
Total .	108 15 4	97 17 10	71 15 4	45 12 9	53 17 1

The other machines, and everything else, are valued on a similar basis.

A gas engine depreciates rapidly, its life not being more than, say, 12½ years, but it is possible to lengthen its life to 15 years, when it will still be running under good working conditions.

Suppose at the end of 12½ years the engine is fitted with a new cylinder, piston, brasses, etc., at a cost of 25 per cent of its original price. This repair will practically reinstate the engine at its full power. At the end of 12½ years, on sale, the probable value is only one-third of the original, but the complete repair will allow it to run for another 2½ years before any further expense is entailed; therefore its useful life is 15 years.

A planing machine has a probable useful life of 20 years, but generally it rests half the time. Presumedly repairs will be needed at the end of 20 years, costing, say, 25 per cent of the original price. Without the repair its market value is probably only one-third of the original purchasing price. The repair at least adds 5 years to its useful life.

These two examples are enough to outline a method of valuation. The gross value of the engine, as a running machine, originally cost £120 17s., and would fetch about one-third = £32 13s. 4d., supposing the engine was taken off its foundation and sold, but another £2 might be got for the pipes, etc.; therefore the difference between the original purchase and the selling value is £86 3s. 8d. recoverable from revenue in 12½ years. This is equal to an annual charge on revenue of £6 17s. 11d. Roughly 10 per cent annual depreciation will meet the demand, plus 2½ per cent interest = 12½ per cent per annum. Thus with £86 3s. 8d. recovered plus £34 13s. 4d. the whole value is recovered, and its interest over the given time. That is, the capital originally expended still exists, and has carried interest over 12 years. But the engine and pipes as dead plant are worth

£34 13s. 4d. The general practice is to wipe off this amount, which means taking it out of revenue.

Under good organizing the firm presumedly buys in the engine at £34 13s. 4d., and expends, say, £50 on repairs, bringing the value up to £84 13s. 4d., or £36 3s. 8d. less than the cost of a new engine, because foundations, pipes and fittings, and fixing have already been paid for in the previous transaction. As a result the firm acquire an engine of equal power to a new one for £36 3s. 8d. less. Thus capital has been saved due to correct organization, and the firm are £36 3s. 8d. better off.

Thus the advantage of adding repairs and renewals to the depreciated value means a sound policy and good finance.

The life of the engine is shorter than that of the planing machine, because the first is constantly at work, whilst the other stands idle about half its time; therefore a very simple method to find the depreciation for any other machine may be obtained by comparing the lives of the other machines with that of the gas engine and taking the depreciation proportionately. This gives $20 : 12\frac{1}{2} :: 12{\cdot}5$ per cent; say 8 per cent for the planing machine.

On such lines the annual depreciation of engine is $12\frac{1}{2}$ per cent, planing machine 8 per cent, and lathe 7 per cent.

For the planing machine 8 per cent of £120 = £9 12s. per annum, or 3s. 9d. per week, and 7 per cent = £7 2s. 6d., or 2s. 10d. per week for the lathe.

The present purpose is to show that a direct charge can be arranged for the use of any particular machine.

These values are but a small part of the general charges, because they do not include fuel and attendance; besides rent, rates, taxing, shafting, belts, oil, water, and many other expenses, which every machine must bear its proportionate share of.

The method of getting at such value is laborious, but experience teaches many things, one of which is that 40 per cent on the invested value will cover all expenses, which may be charged direct to the work in hand.

Taking 49 weeks to the year, of 50 hours per week, or 2450 hours; the capital invested in the planing machine is £120, and 40 per cent equals £48; which divided by 2450 gives 4·7d. per hour, but the machine rests half of its time, which must be paid for, and 4·7 × 2 = 9·4d. per hour, say 10d. per hour for actual running time, which charge is very common in ordinary practice.

The lathe at £95 for 40 per cent = £38, which works out at about 4d. per hour, being another charge that practice uses.

On such lines machines may be charged direct to the job in hand, and the result is fair and reasonable. Charging direct to work in hand reduces the indirect charges as a percentage on wages; but in general engineering 75 per cent on wages will cover all expenses. Thus 75 per cent is an average, because small works such as make tools, stocks and dies, taps, reamers, drills, etc., may require 120 per cent on wages, whereas medium machine tools may be covered by 70 per cent and heavy tools by 50 per cent; but a safe average is 75 per cent for general work.

Organizing always deals with averages, but they are based on real knowledge. Indirect expenses run high when wages bills are low, and low when wages bills are high, and whether the charges are direct or indirect, an average per cent must be allowed to cover fluctuations

Engineering finance is the organizer's province, and he takes careful count of every condition known, and provides for the unknown and unexpected, which experience alone can teach; and it is the unknown contingencies that are the danger and these cannot be avoided, but they can be met and overcome.

Over-estimating contingency must be avoided, because there is a great danger of its so increasing an estimate as to throw it out of legitimate competition. Neglect of contingency may land the contractor in a serious loss; but the fear of facing the question of contingency, by adding a large percentage to an otherwise carefully compiled estimate, can easily shut the door against getting contracts. Capital is useless without work, whilst dead expenses increase proportionately to the volume of trade done.

In another chapter the pitfalls of works management will be further noticed, and the advantages of correct organizing will be pointed out.

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lation possible to ensure a definite result, in spite of the vagaries of intermediate operations.

The purpose of all manufacturing concerns intended to meet some demand is, primarily, to get from capital a higher interest than the mere lodgment of money in a bank produces. It does not alter the fact that some may reap a profit of 5 per cent and others 20 per cent, because the science of organizing assumes profit to be the end of all monetary transactions, and where such profit occurs it shows that the science is understood.

To the outsider the innumerable ramifications of an engineering business savours of the marvellous, but it is only the magnitude that appals. Yet magnitude is one of the things the organizer seeks for, because it enables a much larger number of divisible items to be used, and the greater the number the smaller the gaps to be bridged at a less relative cost.

The meaning will be clearer if an example is taken and worked out; for instance, say, the indirect expenses are £20,000, which are presumedly stationary whatever the value of the wages bill. When wages are £20,000 and indirect expenses the same, then say 100 per cent on wages covers the indirect expenditure; but if the wages drop to £10,000 for the same indirect expense account, 200 per cent must be added to wages; or when a works is running full the bridging is as 1 to 1, but when they are low it is as 1 to 2.

This brings us to a consideration which for years has been used by our American friends to some advantage, and their methods have been copied

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£20,000 = £45,000 for a double output; or with 40 per cent more working capital a double output is gained; therefore keeping a works running full is what works management must aim for, if competition has to be met successfully, and to ensure a profit.

The American method is to amalgamate two such works; though in doing so the dead expenses are double, yet the probable result is a saving of perhaps 28 per cent due to the amalgamation.

But there is a reverse side to the rosy one, which must be considered, viz. a double set of dead expenses—minus 28 per cent; but there is a double lot of depreciation to be taken from revenue, meaning that whilst saving 28 per cent of the dead expenses, the management have saddled themselves with a double set of responsibilities that must be faced.

In the case of the separate firms, under good management, the output might be doubled—with little more capital than that required to pay for material and wages, and the result is an enormous reduction of the dead expenses account, and at little extra expense.

Under the amalgamation, which has only reduced the dead expenses 28 per cent, a reduction of output to say one-fourth quadruples the dead expense percentage on wages; but double depreciation has still to be taken out of only one-fourth of the revenue—which still more seriously affects the issue.

In the separate works the skilful management may increase the output without increasing the amount to be depreciated; besides when running slack of work it does not impose an abnormal loss.

In other words, doing a small volume of work in a relatively small establishment is not nearly so ruinous as doing the same volume in a large works, where depreciation is double.

This is an extreme case, but it shows that size of works, or magnitude, must be considered by the organizer, because works management is assumed to produce under a reasonable output. This part of the subject need not be pushed further, because enough has been outlined to enable an intelligent would-be organizer to develop it to a useful purpose. But this is only a part of the work an organizer has to do in a business where everything that entails useless labour must be put aside, and what is done must be done well by the right people and in the right way.

Whatever other end may be served by keeping a lot of clerks to prepare lists which form part of some much-vaunted system it is not conducive to economy, and a management that requires it must be considered bad. A correctly organized stores would produce a better result and at much less cost.

Another serious misconception that must be avoided, though it often requires courage, is the foolish idea that a well-thought-out system can be run successfully on cheap labour. As a matter of fact the more capable the system the better the class of man required to run it.

The truth is that works management is best served by employing the best expert human element, though it costs more money.

A few hundreds spent on obtaining the best can easily reap thousands; because cheap labour is generally dear in the end, and in organizing it is

always just as well to bear in mind that you cannot expect to buy a gold watch at silver price.

Starting a works is an important part of complete organizing, and locality may be a serious handicap to profitable production, unless conveyance to and from is handy; that is, unless special advantages of another sort will cover a minor disability. These things are too obvious to need further reference, though the land in which works have to be installed requires some attention. It may be freehold or leasehold, yet circumstances may vary enormously.

Freehold land means sunk capital; that is, presumably, recoverable at any time by sale. The original purchase price is not the real value, because all land requires some surface preparation, and drainage is necessary, and be it freehold or leasehold these additional values must be added to the original price, because when crude land is levelled and drained its value is increased. Land, by occupation and building, increases in value; and with other outside improvements going on at the same time the value appreciates very materially. Even crude land is often made a source of considerable profit by buying it at a cheap rate and waiting for future improvements to increase its value before selling again. Much more could be said, but it is outside the present purpose, and to save a complicated issue the organizer is wise to take the original value as the basis of his computations, and the first thing he seeks from revenue is interest on the capital sunk. Where the original capital is recoverable by sale, it need not affect the organizer's calculations, except for the interest to be recovered.

When the land is leasehold, preparation of surface and drainage are equally necessary, and rates and taxes must be borne in either case. The money paid for the lease must be made recoverable over the time the lease runs; also all preparation and drainage costs, taxes, etc., will be included in the yearly payment required from revenue.

At the end of the lease nothing can be recovered, though generally a proviso is inserted in the agreement that the payment of a fine will make the lease renewable for another period. Thus not only have all expenses to be recovered over a time, but the future payment of the putative fine must be attended to, and that means withdrawing money from revenue. The money taken from revenue to provide for the fine is not entitled to interest, because it is capital held in trust for a purpose, and where it is banked it brings interest.

If the works are removed at the end of the lease, the money reserved to pay the fine can be used to assist removal; but the cost of removal, beyond what the fine covers is capital sunk, and must be recoverable from revenue, plus any extras entailed, and all this has to be considered with works management.

Now buildings, plant, and tools, in fact the whole equipment, absorb capital, and must carry interest, besides ensuring a yearly recovery from revenue of capital expended. This is necessary because buildings and the like depreciate and absorb money for repairs and upkeep. Everything of the sort must be taken into the organizer's calculations when seeking a basis on which to charge a percentage on wages to cover everything.

Building a works involves much of the personal element in regard to nature, style, size, and convenience of the finished production, and often popular practice is followed; because it is reasonable to copy what others find advantagous.

One particular class of works construction is favoured where ample room allows its adoption, and for this the northern light-style has many advantages. Though much can be said in its favour, it is equally true that as much can be said against it, especially where space is valuable and unskilled labour is highly paid.

In the present instance the argument refers to an engineering works, and the style assumed is one possessing many advantages, not the least being a saving in space and close connexion.

Suppose we have a rectangular building, of three lengths to one width, lofty enough to carry two tiers of galleries, one above the other, carried completely round the inside of the building, the whole getting light from a well-glazed roof and by windows in sides and ends. With such a construction the organizer equips it in the way best suited to production, to avoid unnecessary delays, and to allow nothing to stop a continuity of production. The method the organizer may pursue, is to keep the clear space between the galleries for the erecting-shop, and to meet the need for moving heavy weights a traveller crane is installed on columns supporting the galleries placed near the roof. The traveller should be the first thing installed, because it will be of use when getting in plant. This traveller must be capable of dealing with the heaviest weight contemplated, yet it must be pro-

vided with gearing to deal with lighter loads expeditiously and safely. Lighter travellers should be installed under the lower galleries to facilitate getting work on to the heavy machines, these being placed on the main floor under the lower galleries.

As the organizer will usually place the heavy tools in a position to save unnecessary waste of time, the planing machines, either of the usual type or heavy milling surfacers, would be placed near the middle under one of the side galleries, and on the opposite side large drilling machines and heavy lathes. Medium-sized lathes and other tools would find a place on the lower gallery, whilst the smaller tools would be placed on the upper gallery, where there would likewise be room to accommodate a large number of fitting benches for light work.

A large part at one end, under the lower gallery, would be set apart for lining out, because it is near though out of the way of the erecting-shop space and receives light from above and from the end windows. A traveller would be required under this part of the gallery strong enough to deal with heavy weights that can be picked up by the main traveller and placed where required. A pair of large doors situated either in the end or side of the building, would facilitate the conveyance of parts to the lining-out department, without causing stoppage of work in other parts; at the other end, or front of the building, is the main stores, standing away from the main wall eight or nine feet, but with a covered way across the space to the door of the main building, leading to which an unencumbered passage-way must be railed off, machines being on either side or as otherwise required.

The stores would be fully equipped under good organizing conditions such as already described in outline, because this is an important part of the organizer's method as it will allow a view of progress and be seen at any time.

The sides of the passage to the stores in the main building is a good place for the examiners, because it is near to the manager and official staff or it could be arranged as follows :—

Above the stores the works clerical staff and drawing office are located—able to get ample light, both from the roof and two sides. Between the clerks' room and drawing office is the manager's office, which extends say, across the space between the stores and main building, giving direct access to the works on the first gallery level, and to other levels by spiral staircases. The foremen's offices are easily arranged at this end of the building, and the convenience of the executive staff being close together cannot be over-estimated.

Following a set plan a large fitting-shop is built away from the side of the main building from 12 to 14 feet, to which it is connected by a covered way. Above this may be the pattern-shop and wood stores, receiving light from the sides, and being sufficiently near to the main building power from the main service for any woodworking machines to be employed. At the end farthest from the front of the main building should be a door and stairs, and opposite to this is the entrance to the foundry; but better still, a covered passage between the pattern-shop and foundry would make communication for the foremen convenient; because the pattern-shop should be really an adjunct

to the foundry for many reasons. Either within the foundry walls or in close proximity is the place for the brass-foundry.

About 20 feet from the side wall of the foundry, where space allows, is the place for the smiths' shop, the end wall being level with the foundry end wall. With this construction crude material could come in at the back to both foundry and smiths' shop, and be delivered at the front where it could be trucked to the main building, or carried to the fitting-shop as required.

In this way the ideal conception of what a works should be is outlined; because crude material is put in at one end and delivered finished out at the other.

Many advantages are obvious with such an arrangement and the all-alive organizer would make the best of them all and gain enormous advantage by centralizing.

Such a works may employ a large number of men where the space occupied is relatively small.

Many obvious additions or alterations to the plan indicated may be made without destroying the general intention.

Drawing office, smiths' shop, and foundry are more or less apart from the actual engineering section, or rather manufacture is comprised of two sections—preparing the rough forms, and finishing and then amalgamating them into the complete arrangement.

As the finishing and erecting processes are the most important from the standpoint of actual production, the arrangement described is good from an organizer's point of view, and good from the proprietor's

standpoint, because it enables greater profit to be made.

The only question dealt with in this description in regard to advantage to works management is that of saving space, because time is shortened between places. This is a constant saving, and in the end means much.

A wise organizer will always provide for expansion, and see that the ground is available. ' The suggested arrangement of the main building makes extension easy, by extending the building backward. The main offices are at the manager's end of the building; therefore extension backwards is possible for the main works, foundry, and smiths' shop.

Such a works, once established, needs organizing so that the capital may be used to advantage. Whatever the expense attending production it must all come out of revenue, but it may absorb all profit; and if it does the management is astray somewhere.

Freehold land presumedly will always fetch the value paid for it, including the improvements or preparation for building and good drainage, but the interest must come out of revenue. Leasehold land over a term is recoverable by yearly deductions from revenue, and this includes interest on a constantly decreasing capital; besides the fine for renewal or to cover cost of removal, must be considered by taking from revenue, over a period of years, sufficient to meet such a demand when it comes, but it carries no interest in that year—though as banked capital it does.

The whole cost of buildings represents sunk capital, and at the end of a lease the whole must be recovered,

plus interest. The cost includes drainage, water, gas, etc., also sanitary arrangements, power house, offices, stores—in fact any and every equipment that costs money.

Plant including tools have already been dealt with. Stock is another important item which should be valued at prime cost, that is minus any profit. Stock retained year by year suffers depreciation and must be dealt with. Drawing office, pattern-shop, engines, shafting, belting, oil, waste, water, gas, rent, unskilled labour, clerical staff, official staff salaries—which include the commercial expenses, besides stationery, law costs, insurance, losses by accident to men, machines, or material, bad debts, advertising, and many things charged up as petty cash, all enter into the organizer's calculations.

Outside of these things bad times must be provided against, strikes, lock-outs, panics, and a whole host of possible happenings, many of which may never occur.

Most difficulties are found in works management in the human element, and that needs attention, tact, and judgment.

It has often been asserted that workmen are what the employers make them, and experience proves that to "treat a man well, and he will do well by you," is true, and generally it pays. An idea is sometimes prevalent that workmen should understand the particular idiosyncrasies of their officials and this becomes a rock on which a good business splits.

A good official tries to understand his men, however variable they may be, and he should know them as well as the class of material he is using. When

workmen have faith in governing heads, business generally flows easily and in one direction, and that the right one.

Perhaps the human element in business is appreciated too little. As a fact, much rests upon it, and the capable organizer includes attention to it as a valuable part of works management.

The organizer who is afraid to employ clever specialists can never hope to be successful in profit-making. The best advice to give any official is that of gaining the respect of those under him; this can only be done by being honourable and truthful. Further it adds much to the responsible manager's chance of success if he impresses the men with a good idea of his ability.

A reminiscence will add point to the advice. The fitters of a works interviewed the manager and complained that he had broken one of their society's rules by employing unskilled labour to do what skilled men thought to be their work.

The men were right in one way and wrong in another. The men in question on the job were merely putting up a lot of hydraulic presses, roughly, viz., base, pillars, and heads, and they acted under their manager's personal command, and no one denied that he was not a skilled man. The cause of the hurry was that unless a certain number of presses were at work at a given date a fine had to be paid, and as the next day the demurrage commenced, due to want of men, the manager tackled the donkey part of the work, intending to put on a number of men that night to complete it.

The workmen had faith in their manager and he

respected them. In spite of a bad half-hour that the men had, they returned before the time of leaving off and asked permission to go and finish the job that night.

In the morning the job was reported complete, and on examination it was found to be satisfactory. The particular men engaged on the job had their time-boards placed before the manager, but not a man had charged a moment to the job.

The spokesman of the men was sent for and was asked the meaning. He said no one would take a penny for the job, though he asserted that they had a right to complain; but the special circumstances, and the honourable way they were always treated, were the reasons why the work was done.

Most workmen behave like that if they are tactfully handled and treated with respect. If they don't, you should get rid of them.

CHAPTER IX.

SOME EXISTING BUSINESS SYSTEMS.

SYSTEMATIZING production has perhaps received greater impetus from American enterprising methods than from any other country.

Many books are extant, the production of specialists, written either by those interested in some particular system, or at their suggestion, and only one opinion is possible after reading them, namely that it is possible to install a system that will need practically no management; because the perfectness of the method gives automaticity to business procedure and prevents the possibility of any mistake.

Following closely upon the heels of American methods, learned exponents of some particular system thrill the readers of their books with anxious desire to win fortune by adopting methods that are exploited energetically, under romantic headings, which too often leave a thrill of disappointment when failure attends a close adherence to the rules laid down. This is unfortunate, because much can be credited to the systems in regard to numerous details, and if wisely embodied in a good organization, good results will follow; whereas, as a whole, they woefully fall short of anticipation, merely because they all attempt the impossible, and failure results.

Works management has to deal with extraordinary conditions of a very variable nature, and no amount

respected them. In spite of a bad half-hour that the men had, they returned before the time of leaving off and asked permission to go and finish the job that night.

In the morning the job was reported complete, and on examination it was found to be satisfactory. The particular men engaged on the job had their time-boards placed before the manager, but not a man had charged a moment to the job.

The spokesman of the men was sent for and was asked the meaning. He said no one would take a penny for the job, though he asserted that they had a right to complain; but the special circumstances, and the honourable way they were always treated, were the reasons why the work was done.

Most workmen behave like that if they are tactfully handled and treated with respect. If they don't, you should get rid of them.

In other words, A buys and B sells. It is enough that A keeps an account of the ordering and the receipt of the article, whilst B keeps an account of the receipt of the order and its fulfilment.

To assert that the secretary must sign the requisition when he can only know what the manager tells him, or what the books show in the final stage, is simply wasting money and time, and is red tape unadulterated.

Under bad management the secretary's signature may have a sort of restraining effect; but instead of wasting the secretarial time, and complicating the system of book-keeping, good management should be provided.

To go through an unending series of questions as to why the goods are required, and for what job, and who says so, etc., is to strain at a gnat and swallow a camel. It is really due to rank bad management, or the desire to do without it altogether, and no honourable manager who is a competent organizer would permit such an anachronism to harass good organization.

Quoting from a well-known work on the subject: "The *requisitions* are sent to the *Purchasing Clerk*, who fills in the supplier's name and address, the supplier's designation for the goods required, and the *Order Nos.* He then hands them to the *typist*, who makes out the *official orders* from the *requisition.* When the orders are typed the Purchasing Clerk compares them with the requisition, and if correct, initials the orders on the left-hand margin.

"The orders and requisitions are taken to the Secretary for approval and signature. Two carbon copies

are taken of each order. One is simply filed on 'Unexecuted Outwards Order File'. This enables the chief of the office to go over these and take up any case of exceptional delay. The other copy is sent to the Receiving Department, but not until a promise of delivery has been obtained from the supplier.

"This serves the double purpose of letting the department know that the goods requisitioned have been ordered, and also when delivery may be expected. The outward orders are press copied in a special 'Outwards Order Book'. The No. of the order gives a reference to this book; thus a copy of order will be found in a certain book on page something." To go on with the abstract would be both wearisome and useless, because such procedure to an organizer is anathema.

Under good organization the storekeeper requests on a date, and part of the form on which the requisition is made is returned to the storekeeper, notifying that the goods were ordered by number so and so, and date. The storekeeper inscribes the number ordered and date on the label belonging to the particular order, and as the goods are received, date of receipt and quantity are also put on the label.

Whether ordered from the manager's office or from the buying department, the requisition is issued by the one who knows—the manager. The storekeeper must be able to pass the goods when they arrive, and the label allows anyone to see how the order has been attended to. In the event of delay, the storekeeper notifies the manager who attends to the matter.

When the invoice comes in it is sent to the

manager, whose signature is sufficient to prove receipt, price, etc.

Thus the transaction of buying and selling is carried through on simple, safe lines, and at little cost where the manager is the responsible organizer. The other case shows poor management or none at all, and to prevent error an endless lot of red-tape is indulged in at considerable cost, which is taken out of the profits. By one of the so-called infallible systems, the requisition side of the transaction is a fine art, and the invoice side is another with a lot of in-between operations, too numerous to mention.

Works management is not a fine art, though it is scientific, based on practical ability.

Cards are handy and serve a useful purpose; but if the intention is to do away with the human element, they woefully fail in the purpose intended.

A capable organizer is always careful of works costs, and shy of being charged too much, yet honourable enough not to be charged too little. It is only by careful superintending of all things that cost money, that organizing can be made efficient.

In regard to material value, the two stores day-books—one of which is in the general office and the other in the stores—clearly show whether material has been under or over-valued, and an inspection of the stores labels enables manager and foreman to keep a check upon waste.

The purchase-book should be an epitome of all buying transactions, and everything crude or finished is taken to or from the stores, therefore all material values are derived from the stores day-books, in regard to quantity or for small details, at a price.

Some purchases will be charged directly to jobs in hand, though others are charged to the indirect expenses account.

An analysis of the purchase account is necessary for three sections, viz. purchases charged direct, those charged indirect, and sundries, which include everything needed during manufacture, but are used in such small quantities as to make it impossible to charge direct. These are termed indirect expenses, but all cost of material for manufacturing purposes should be known for future estimates.

Works management aims at economical production, and that supposes low, dead expenses.

Purchasing large supplies when rates are low is good practice, but it is limited to good judgment. For instance, crude material requires little or no attention, but the purchase of a number of sets of apparatus, because their price is low, may easily result in money lost.

Suppose it is a motor-car works, and magnetos are down 12 per cent, and a heavy purchase is made, sufficient to supply all demands for a few years.

Every year the quantity in stock suffers depreciation, sufficient to cover lost interest, attention in regard to cleaning, etc., which may easily mean 10 per cent. Besides some may lose their magnetism and it costs money to reinstate them. Where a 20 per cent loss can be shown at the end of three years or so, it cannot represent an economical purchase, therefore judgment is needed when purchasing at a low rate.

Purchasing a stock of pig or bar iron when rates are low is likely to be advantageous, and save money

in a few years to come, if the purchasing price is low enough to warrant the required outlay.

Purchasing a lot of copper at £30 one year when the market price shows every tendency to rise to £36 is a wise move, because the money saved over a year's purchase to meet usual demands may be enough to cover depreciation.

During the progress of work, when getting out orders, no unnecessary extra expense should be allowed, not even though it enables a stage to be understood better than under more simple methods if in the end the result suffers.

Registering orders is necessary, but it need not be elaborate. Simple but correct book-keeping is all the true organizer desires, because the means arranged to check irregularities and to anticipate difficulties only to meet them forms part of the organizer's task.

Costing, or definite knowledge of what it costs to produce, is of all things most necessary, because it forms the base for future enterprises, and no wise organizer would neglect it. He dare not if his organizing is to be successful.

Endless are the things works management must consider, but experience gets rid of endless worries and leads to easy methods of meeting difficult problems.

The difference between good management and that bolstered up by an assumed infallible system may be compared to buying sand by weight, and purchasing by the number of grains assumed to be in a given weight. The idea is absurd; but purchasing coke by weight may mean a loss; whereas buying by bulk saves money frequently.

To prevent error in regard to time of delivery, the schedules supplied to the manager should give the time when the contract has to be completed, and the storekeeper should note this on the finished label, so that the foreman can see it at any time, and a tax on memory is avoided.

Some work is not hurried, whereas others are required quickly, but it is unwise to let any job hang fire. If not wanted before a distant time it should only be begun to suit that time, and where other orders come in to interfere with work in progress, a definite stoppage of the one must occur when the other takes its place.

This is one of the points where organizing elastically is of advantage, but only the manager defines the limit, and he, assuming he is an efficient organizer, never loses grip, so that the limit is never overstepped.

To attempt an analysis of every existing system would require tomes instead of one book. Even if they were examined the object before the writer would only be delayed, not assisted.

This brings in a sort of quibble as to what systematizing really means, and how system is not organizing.

System is included in organizing, but organizing is not system. The student of works management must be able to define the difference, and if he is unable to, he will never become a successful organizer.

Suppose all steam-engine makers determined to standardize productions, so that some part produced by one firm could be used in the engine produced by another, that would mean interchangeability, and at first it would be of advantage to the

users; but in time the system would become a serious disadvantage, even to buyers, because standardizing would stop ingenuity and breed mediocrity of production.

The brainy manufacturer would be no better off than the mere drudge, and before long a number of firms would either cease to produce, because they could not compete under the system, or a few would coalesce, so that quantity would lead to economy, and as others would be unable to compete, they would be ruined.

As it is, with the large number of steam-engine makers existing, each claim some advantage by some particular feature from which they reap reward; whereas under a system of standardization, either all would lose or a few gain at the expense of the others.

No one doubts the possibility of systematizing by standardization, but most will acknowledge that loss will occur before long. As it is all can now organize to produce their separate manufactures to give excellent results besides reaping a profit by the transaction.

Perhaps a better way to state the case is to say that systematizing tends to reduce the power of the human element, whereas organizing seeks to increase its value.

When every expense is covered by a percentage on wages, the value plus wage and material is the value of output minus profit, and if no profit results it is due to faulty management.

Now, profit cannot be declared until invested capital is accounted for, and capital is accounted

for partly by recovery from purchasers' payments, or from the value of buildings, plant, etc., as depreciated, investments outside, or bank balance; but beyond this bad debts and other contingent losses must be anticipated and provided for, before profit can be considered.

To explain what leads to a profitable ending it is necessary to traverse the whole ground involved in producing over one year, and to illustrate it an example is given.

Suppose stock at the beginning of the year in a works is valued at £15,000, and purchases of £50,000 are made, the total becomes £65,000; but stock at the end of the year may be £5000, which shows that all has not been put into sales. The value is £65 000, of which £5000 is still in stock, and is included in capital investments, so £60,000 must be accounted for in sales.

Supposing the sales are £100,000, the first reduction is £60,000, and that leaves £40,000. from which wages may equal £16,000; salaries, £5000; repairs, etc., £2000; lighting and power, £600; rates, taxes, water, insurance, £1000; general expenses, £1500; stationery, travelling, etc., £6500; general advertising, £3000; making a total of £35,600, which leaves £4400 profit; because depreciation is supposed to be covered by appreciation of capital. The balance covers interest on the capital at the rate of $2\frac{1}{2}$ per cent, therefore the balance after the $2\frac{1}{2}$ per cent has been deducted is what may be termed profit derived from using the money for manufacturing purposes.

A few important items have not been mentioned, such as directors' fees, auditors, legal expenses, and

interest as loans from bank, if any, and these may mean £1500, and 2½ per cent makes £4000, therefore the remaining £1100 is loss entailed. A safe method is to assume that the turnover is equal to a proportion of the capital invested, plus a percentage added, referred to a year.

The preceding outlining assumes that variations occur which influence increase or decrease of the profit side of the matter; but it is equally true that variations are limited by conditional factors that are recoverable over a time.

Though plant and stock values may increase or decrease it does not follow that wrong values have been given to them, but plant value is affected by depreciation, perhaps abnormally in some cases: therefore, revaluation should be insisted on every seven years, because this experience proves that time to be the best. Generally, and perhaps wisely, depreciation percentages reduce the value too much, so revaluation every seven years puts it right.

It is generally assumed that percentage values are the simplest and safest way to test output value by, and whether they are as correct as they might be or not they give a ready means of comparison into the hands of the organizer.

Roughly, 120 per cent on the wages bill, plus wages, plus material, plus a percentage on the total, should cover every expense, and allow a profit.

The general experience is that, for general engineering purposes 75 per cent on wages will cover works expenses; therefore it may be safe to assert that 45 per cent will cover commercial operations as usually conducted.

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less material to bridge, and leave less likelihood of estimated values being wrong.

The whole trend of works management is to avoid needless expense, yet to be niggardly in nothing, and above all to deal with practical and not fanciful matters, and if these points are well observed profit is more certain than loss.

CHAPTER X.

DIRECT VERSUS INDIRECT CHARGES.

THE previous references were in regard to placing a given percentage on wages, to which an objection may be raised such as that when a works is fully employed the cost of producing is less than when running slack. On this point there is much diversity of opinion amongst men of recognized ability in works matters.

In these days of keen competition each article has a value, and whether it is produced in a works running full or in one where work is scarce one price rules its sale.

The per cent addition named for works expenses is the average between the best and the worst, and it may be justifiable to say that the average is 75 per cent, the lowest 50 per cent, and the highest 100 per cent.

Fortunately good and bad trade seem to run in cycles of seven years, and these include the 100 per cent and 50 per cent conditions, for which reason the average is taken as 75 per cent. The market rules the purchasing rate, therefore the right thing to do is to take advantage of the lower rate to store the reserve for use during the high rate.

It is possible for two firms to contract for similar articles, and each may obtain a share, but one may

be producing on a low wages bill and the other on a high; but the market sets the price and the two firms abide by the result, the one losing and the other gaining. Because such disparities exist many say that a percentage to cover every expense is wrong and argue that the lower wages bill makes the cost of the article higher. That is true, but the price is stationary, and customers would refuse to pay more. By placing a per cent value on wages of, say, 120 per cent as an average, the lower rate of the high wages period is neutralized by the higher rate of the low wages period; though many urge that a direct charge for machine use should take the place of the average percentage, then the charge would be on the actual time, or a direct charge would be right and indirect wrong.

It is obvious that under the conditions charging by a percentage on wages to cover all expenses and charging up the value of the machine time direct would still show a loss to the firm, though the original cost of the production set by its market value would not be altered. The suggestion that it would is both captious and unnecessary.

If anyone wishes to adopt the hour method of charging enough has been said in a previous chapter to enable any intelligent engineer to fix the required rate or to test the average percentage value and so satisfy himself as to its advantage.

Wages are paid weekly and material costs are readily ascertained by reference to outside purchases or stock returns, and knowing that production of all kinds bears its share of indirect expenses, it is evident that an increasing production on the same

indirect expenses value is cheaper, and on a low production it is dearer; yet the average of the two opposites is met by an average percentage charge on wages. Thus the average per cent method is at once the most direct and the least expensive, and the result is equally good.

Works management must always take the most direct road where that is available.

The endless variety of almost innumerable items makes it expensive and laborious to trace back every one to its source, especially when that source is not well known or described. Attention to every detail is necessary; but conserving all attention on one and neglecting the others will only make confusion twice confounded, and instead of aiding the end in view, it will add to the tortuous paths and tire out the seeker long before he gets there.

It must be asserted that works management is not an exact theory, and any attempt to act as if it was only proves how mistaken the operator is who tries to produce what is impossible. Organizing, as the fly-wheel of commerce, must store at one stage and give back at another, and unless it does that there is something very wrong with the power machine.

Every difference of opinion in this matter shows how much the human element is to the fore; therefore merely systematizing methods will never reach the end intended. Entire reliance on any system, however good, is the broken reed of commerce, which will pierce the hand of the user unless he uses wisdom that is born of experience to aid him.

No month in twelve will exactly compare with

another ; therefore to elaborate monthly balance sheets is to waste money and time without reaping advantage, and such methods may be termed meticulous, being rather a proof of weakness than of strength.

An insufficiently thick plank, bridging a chasm, does not gain extra strength during the time the would-be user stands hesitating before taking the passage. The object is to get from side to side in safety, and with twelve months as the width of the gap it is sheer nonsense stopping at every foot to calculate the strength of that part. It only adds to the danger of the moment to keep an unnecessary stress on the flimsy structure, besides it delays the time of crossing, and in business, time is money, and money spent to no good purpose is lost.

Works management is like the flimsy bridge, because it takes some courage to walk it, but the wise negotiator knows that the safest and quickest plan is to get across the gap without delay, and without unnecessarily stressing the structure of doubtful strength.

If the plank is so weak that it will not bear the weight of the passenger, it becomes criminal to stress it unnecessarily, but it is wise to strengthen it. The same thing is done every day by our bridge builders, by strutting the weak parts.

Loading a works with a clerical staff merely to satisfy a nervous curiosity is bad management, and exposes want of knowledge and want of confidence in the methods adopted.

Whilst works management must understand the details the general object is a short and a merry way to get to the end. Americans call it cuteness,

whereas it is ability properly applied. Routine avoids clashing; but routine that is invariable when set to straighten out an erratic set of movements will inevitably end in disaster; therefore organizing in works management is supplying what is best fitted to meet emergency with the least loss to the end in view.

At this stage some little attention must be given to what is called centralizing production, and it matters not if some firms using it do make a profit; the suggestion is that by another method they would make more. The fault lies at the door of so-called system, which energy and other good factors may save from becoming a direct source of loss.

Centralizing production means a sort of clearing house into which every article, after one or any operation, is taken to be examined. The mere taking and bringing away again costs money and wastes time.

In works where repetition work of a small size is produced in tens of thousands, the articles may be taken to the central stores a dozen times, where they undergo examination before the next operation is performed. Such transit from and to a central position is bound to interfere with the general conduct of progressive movement.

Examination is necessary, but that is easily met by having as overseer a capable man whose emoluments rest upon the accuracy of the production he is responsible for.

If a reduction is made for bad work he will take care to produce good work, because that means extra money to him, and he, in turn, mulcts the operators

for bad work, and as that means a low income they exercise care to produce good work. The cost of the supervisor is covered by what it costs to keep a large number of examiners busy plus the cost of transit to and fro many times.

The final examination of the completed article will locate the point where the fault occurred, if any, and the desired purpose is attained—a properly turned out article that is a replica of the model.

In a large manufactory the cost of people employed in the transit operations, plus loading and unloading, may easily be 5 per cent of the wages of that department, and this is lost profit.

The examiners engaged on the larger class of production can only pass an article if it conforms to their instructions and limit gauges; but all such discarded stuff must be subjected to expert examination at an inquest in the so-called coroner's court, which was early referred to, and from that court's action many of the condemned pieces will be saved, which will mean a considerable saving of money to the firm. These are matters for works management to seriously consider.

Another simple matter is the cause of endless expense, viz. the holding down plates and bolts used for securing work to be machined. Sound bolts and nuts and suitable plates should be provided for every machine tool, because otherwise much time is wasted when fixing work, reducing the possible output of the machine and making the cost of production high.

Makeshifts are responsible for many of the contingent happenings in a works, which might be avoided by expending a few pounds, and thus per-

haps saving hundreds per annum. Even here there is a danger of expending too much on accessories to a machine by wishing to reach the ideal, which is impossible; therefore the human element must be organized to learn the difference between ideality and practical utility. This again shows the necessity of organizing being elastic; no rigid system will pay.

Another mistake that may cause unnecessary worry and annoyance is when new machines are bought for factory use, and the output given by the maker is based only upon the machine's capability. Such a case occurred in the writer's experience where the guarantee was for 100 per cent, whereas the actual possible output considering the human possibility of fixing and unfixing the work to be done was only about 25 per cent. In this case the directors were jubilant to think that future output of greater magnitude would be met by one set of machines, whereas four sets would be required to produce what was given as a guarantee for one set.

There was no intention to deceive, but the facts as they were known, and an explanation before directors and seller saved much annoyance that would have arisen at a future date. This shows that the organizer must deal with practical results and not with theoretical calculations.

Fashion in production sometimes bothers the organizer, who must be able to deal with it when it interferes with what he knows to be wise methods. Another reminiscence may be given in reference to a twist drill which was said to be capable of doing more work than any other; this was years ago when twist drills were being pushed by American specialists.

The assertion was that a twist drill would do more and better work than any other; but this was disproved by a turned and planed flat drill with the cutting edges undercut, which drill did as much as the twist drill, but the holes were as smooth as if rose-bitted, whereas the twist drill holes were as if threaded. These examples are given to prove that the organizer's task is not easy, and that he must be a strong human element to know what is best and how and when to use it.

Attention to all these matters helps to reduce both the direct and indirect expenses, showing that experience is a valuable asset in works management.

Stocktaking.

Stocktaking brings us into the field where the indirect expenses may be increased or reduced. Stocktaking includes work in progress and its value, and that is best ascertained by reference to the books, supplemented by an examination that the work faithfully represents what the books indicate.

Stock value is taken without profit, and the old term prime cost is the best, because it assumes that every expense entailed in the works has been considered. As already suggested 75 per cent added to wages, plus material value, will usually give the prime cost for unfinished work.

Any other method of valuing work in hand is wrong, because the stage is not reached where the commercial value begins to be of use; therefore all stock value is best based on works costs alone.

Stocktaking under good organization of stores becomes a simple matter, though the time of stock-

taking should be used as a check on the stores records, as indicated by the labels; the labels should give a fair indication of work in progress in regard to the various operations completed.

With a properly organized stores, a rough value is possible at any time by reference to the labels alone.

Stock taken year by year is increased by new purchases and decreased by the contracts on hand. One method of valuing stock should be adhered to year after year, and no alteration should be made until after due and serious consideration by the qualified authorities.

Material which has become useless from any cause should be scrapped, and only when a comparison has to be made of one year with another should the scrapped material be considered at the original or last year's value.

A good plan is to indicate all scrapped articles by red ink, and any alteration should be made in the same colour.

Some old stock may have to be valued, and the valuation of the previous year should be the base, and any alteration of value should be recorded in red ink for easy reference, so that differences in store value for the same material may be seen at a glance.

The division of works costs and the total indirect charges furnish a convenient method of testing the comparative working values. If an analysis shows that the commercial expenses are more than 45 per cent of the wages paid to workmen, there is evidence that organization has got adrift, and the same may be said of the works if analysis shows more than a 75 per cent charge on wages.

Under usual conditions these percentages are practically standardized, and form a good basis for all general computations.

Where the management reaps a benefit from output or on costs saved, the management's figures should be carefully examined, because there is naturally a bias on the side of the one personally interested, however honest the intention is.

As works management is proved by the successful issue at the end of the year, it is a good plan to pay the manager a bonus on all money saved, outside of the usual salary.

The works management is presumedly the work of an expert, and all stock values should be signed by him as the one responsible for the whole transaction. In the case of a company, to have the Managing Director signing is an absurdity, because he probably knows nothing of the true value, or the operations by which it was arrived at.

Auditing the accounts of any firm is important, and large auditors' fees may be the cheapest way to success. At any rate it ensures accuracy.

The profit and loss accounts largely rest upon the correctness of the stock value, and should receive the close attention of auditors. It will save time, prevent annoyance, and produce a good result if one of the auditors' official staff goes over the stock lists w the manager before his signature is appended; the lists should be signed as witnessed by the person representing the auditors. The red-ink indications would aid this examination materially, because explanations would be given there and then, and save future quibbling.

Perhaps the most important duty of the auditors is to see that all purchases, as recorded in the purchase book, are traced into the works and accounted for.

The stock sheets should be divided up and summarized to show different stocks, apart from the value of work in hand.

The following merely indicates a method by which stock is taken and valued, which allows a reference to the drawing, and enables a sight-view of the rate at which the article was valued the previous year. The arrangement given is generally used by the writer, because it was found to suit the purpose intended.

Plan of store list:—

STOCK LIST NO. 10

Date	Drawing No.	No. in Stock	Class of Material	Weight or Finish	Rate	Value last Year	Total
18	51A	36	Gun-metal	3 1 20	10d. per lb.	— for 18	£16 0 0
19	53A	20	Steel	—	—	£1	1 2 6
30	59A	5	Wrought Iron	Partly finished	—	5 cost £10	10 0 0

hus the stock lists run on, and where articles are partly or wholly ished, they are rated in accordance with the previous year's valuation. his valuation is proved to be in error, the difference, plus or minus, oted in the out column in red ink above the total.

With such stocktaking reference is easily made to the drawing, and the cost book will give the value of the work put upon a finished or partly finished

article. If intelligently carried out the nature of the valuation is unchanged from year to year except as noted by red-ink indications. When dividing and summarizing, an index mark in the No. of Bin column shows whether it is actual stock or work in progress. *S.* means stock and *P.* means progress.

Oil, waste, emery cloth, and such-like goods are listed together, and therefore stand along.

The same thing occurs with files, chisels, hammers, and such-like tools. In like manner, taps, dies, stocks, drills, reamers, etc., are taken as tools, pure and simple, and are valued by reference to the previous year's valuation minus a depreciation agreed upon.

Summarizing takes a form as follows :—

End of financial year 1905, taken 30 August.

Value of pure stock	£6560	7	6
Value of unfinished contracts in progress	4230	10	11
Sundry stores	680	19	4
Files, chisels, and hammers, and such-like tools in store	573	0	0
Small tool valuation	3974	18	9

Special Notice.—Stock as valued last year was at the rate of so and so. This year valuation (special) has increased or decreased it so much.

The above figures are chosen at random.

Suppose goods of value £46 appear in the purchase book, of which trace is lost in the works, and no account appears on the stock list, then a reference to the sales book shows that these were obtained on an order from a customer, and were sent away direct, and not through the stores. The matter is settled thus far ; but a rule has been broken, and the cause of the breakage has been traced to an over-zealous servant. The discovery of the dereliction

probably prevents its re-occurrence, because the delinquent is admonished to avoid such a transaction occurring again.

When finishing up finally at the end of each year, any matter that has got out of the organizer's reach, no matter how small, is traced to its cause and the remedy is applied. Thus continuity is established and errors grow less and less under correct organizing.

By such methods and others that are obvious all direct and indirect expenses are accounted for. In this connexion auditors and manager act as guides to each other, because their interests are both centred in the firm's welfare.

Whenever the Auditors find errors they should be clearly noted, and afterwards the Manager should be called upon to give an explanation. Dereliction of duty on either side or errors made must be noted, because only by such close examination can the human element be kept in order.

Necessarily it is only possible to briefly outline the proposed methods, but with the information given and common intelligence the whole field of locating direct and indirect expenses can be covered with certainty, and brought to a successful issue.

CHAPTER XI.

THE UNDERLYING PRINCIPLE IN ORGANIZING.

WHERE a ground principle affects a large number of widely different productions it is impossible to lay down any hard and fast rule to guide the one responsible for works management. An engineering works, as shown, needs so many adaptations of the principle to a practical end that it is clearly impossible to tabulate a set of rules, because the working out of the principle leads to so many avenues, none of which coincide as to length, though all lead to one end—making money.

Whether it is a general engineering works or a soap manufactory the same principle is involved, though diversely applied.

The soap works starts with the crude material, which must be bought and stored. To keep trace of purchases and to account for the value of stock held similar methods to those adopted in the engineering production are used. In fact it is impossible to disconnect the methods adopted in one case from those utilized in the other. Work in progress at the time of stocktaking must be valued, and the stores will hold material that has undergone treatment to refine it from some of its impurities.

Buildings are needed, and plant must be installed,

whilst tools of various sorts are a necessity. Rent, rates, taxes, official salaries, workmen's wages, and all such-like are very similar in the soap production to those required in engineering. Sundries are needed, and indeed it is impossible to state a case in which the principal factors are not required. Clerical assistance and professional service of the chemist, who is the practical designer, and corresponds with the draughtsman of the engineering section, are required, and the commercial transactions run on similar lines, whatever the commodity dealt in.

The underlying principle is to produce at the least cost the best article, and at the end assure a profit. If this does not occur some non-adherence to principle has taken place. The only difference is magnitude and dissimilarity of detail.

Bad debts will occur in either case, and troubles will arise that must be anticipated and provided for. Thus a previous assertion is borne out that an organizer need not be practical as an exponent of the manual side of the business he organizes, though it is an advantage to know about it particularly. It sometimes happens that the mere specialist makes a bad organizer, inasmuch as he organizes on the lines he has been taught, instead of dealing with the ground principles involved. Whilst this is true it could not be counted good policy to get an engineer to manage a soap works, though it might be the best thing to do if the soap expert failed.

The trained engineer is a cosmopolitan piece of humanity, and no manufacture exists that does not, in some way, require his aid; therefore his univer-

sality of knowledge enables him to organize, even in those things in which in actual touch he is lacking.

Philosophizing on such a subject as works management will not teach the embryo manager his duty, but it will help to give him courage as an engineer. His training plus natural aptitude will fit him for most posts he may occupy or anticipate.

In every case it is true that poor wages are no criterion that the end will be a success, and to measure out the result of twelve months' possible production by what has been proved possible in a day is sure to land the calculator into a result that will disabuse his mind of the advantage of merely being a good mathematician.

Getting the best at the cheapest price is true economy, and employing the best men and paying them their true market value is what a good organizer aims for.

Employing young officials because they are cheaper than older and more experienced men, is unfair to the young men, and disastrous to the business. Many have tried and many have failed, and it only needs time to prove that experience is the cheapest in the end, though it has to be paid for.

Pay for everything at its full value, but take care to get a fair return from either human element or material commodity.

Works management is really tactfulness in dealing with awkward happenings, and tactfulness is born of experience and ability to know what is the best. Whilst mere length of service is a testimony to steadiness, it may not be a test of actual ability; length of service should receive monetary recognition, but only

merit can demand an adequate payment for services rendered. These points, and many others, must be considered by the management.

In works it is sometimes said that some machines are productive and others not. This is a mistake, because all are productive if necessary. A grinding stone in general practice is not actually productive, but it makes production easier of attainment; and although it is impossible to charge for the shop grindstone by time, it is and must be charged for in the indirect expenses account. A traveller, or crane, comes under the same category, even as the men who sweep up the shop and keep the windows clean.

One common fault in many works is to look upon the costs incidental to cleanliness as wasted money, and attempting to save in the waste bill by cutting down supplies below what is really needed.

To the capable organizer this principle of cheap working is obnoxious, because he knows it does not pay.

Another reminiscence bears upon this mistaken idea of saving at the tap and running out at the bung-hole, and that refers to timekeeping. Time-keeping—that is, getting men in to time—is good and wise, because it ensures them being at work; but it is of very minor importance when measured by minutes, though it is most important to keep men going when they are in the works.

In the case named it was proposed to install time recorders, which would mark the minute the man recorded, and one high official declared that 2000 men tied down to one minute meant £50 saving in one year. He rightly said that it was worth saving,

and that a few £50 would pay for the recorders, then afterwards the saving would be profit. Evidently the recorder seller had impressed him. Now saving a minute of 2000 men's time must not be decried, but experience teaches that hours of lost time will occur day by day if the men are not watched, and that becomes a serious loss. The capable organizer is not so foolish as to measure a man's value by what he does in the hour, but he does expect full value over the week's work. If a man is inclined to lag unnecessarily, the foreman, if worth his salt, soon sees that the opportunity is not allowed, because such a man would be seeking another job.

Keeping the time engaged on details of a job aids costing and estimating, but the best systems are inaccurate unless the foreman *vises* the declarations. Certainly this is looked upon as being old-fashioned, yet it cannot be beaten for accuracy, where the right man is in the foreman's place. It means that in organizing there is caused a wholesome fear that laziness will be revealed; good service and ample results by correct methods can never be expected by merely ensuring a man's presence in the works dead on time.

Unfortunately men will take advantage if they can do so without discovery, and the organizer's purpose is to make such discovery easy.

Intelligent, capable foremen, well paid and appreciated, with the aid of a stores as previously outlined, and a good organizing manager, may be expected to get the best results at the least cost.

Knowing when to let well alone is worth much, because much time and money are wasted in doing

what might be left undone, and not doing at one time that which must be done at another at a greater cost.

Spending £1000 a year on clerks merely to produce weekly returns that serve no other purpose than supplying knowledge that is of little value to the one demanding it, is an evidence of little faith in management and does not bring profit any nearer, but rather causes it to dwindle.

Week by week the management must gauge progress, but this can be obtained very simply, if the manager is capable, by taken percentage values of the various departments referred to the total wages, and in a general engineering works, where a multifarious production is proceeding, this will furnish a rough gauge of what ultimately may be expected.

But this is very different from what is termed an up-to-date digest; that involves much clerical aid and great expenses, and no adequate return.

This does not mean that any laxity is allowed, but is rather indicative that the true principle of economical production resides in going on without loss of touch at any moment.

Detailed rates of progress will be kept of every machine tool, and as all machines must be numbered the workman's declaration includes the number. The manager's clerk analyses the weekly sheets quite readily, and the items are entered in the machine record book.

The schedule supplied to the manager for his especial use, from the drawing office, gives the various operations and their estimated value, in which the drawing office are aided by the costing office.

The following is an example of the machine record book.

MACHINE RECORD

	Number of Machine	Class	When Purchased
Week ending Jan. 1904	10	Milling Machine	Aug. 1889
	11	Milling Machine	Jan. 1902

Charge Rate per Hour	Operator and Ticket no.	Hours Worked and Rate	Rated Value	Productive Value
6d.	T. Smith. 750	50—6d.	£2 1 8	£2 10 4
7d.	S. Jones. 890	50—7d.	£2 4 11	£2 19 6

These two examples are quite sufficient to indicate the method of keeping the machine record, and showing the advantage of its use.

No. 10 is, say, 15 years in use and the operator's rate is 6d. per hour, and the calculated value of output is £2 1s. 8d., whereas the productive is £2 10s. 4d.

No. 11 is a new machine, 2 years old, and its operator is paid 7d. per hour, but its estimated output is only £2 4s. 11d., whereas the productive is £2 19s. 6d.

An examination of the cause of No. 10's lack of equality with No. 11 shows that No. 10 cannot be

driven faster, but No. 11 should be able to largely increase its output, and the operator is capable of doing so.

The worker's rate is increased to 8d. per hour when the production value reaches £4 per week. By increasing the operator's wages 13 per cent, referred to 50 hours 4s. 2d., the productive value is increased £1 0s. 6d., or increasing production 100 per cent it gives 80 per cent to the firm and 20 per cent to the operator.

Thus successful organizing increases the productive value of the machine £1 0s. 6d. per week, and the workman is 4s. 2d. better off; or a clear saving of 16s. 4d. per week is effected on one machine. No doubt the machine will wear out faster, but it will still leave a good margin to increase legitimate profit. This is organizing to a profit, whilst giving consideration to the human element, and in all cases such consideration produces an advantage.

Anything adopted by the organizer to gain such a result is in the right direction, because something is given that produces more than the cost involved.

A similar method referred to every department provides all the returns required, because the totals, as estimated and produced, are indicative of either loss or gain, and where production is greater than the estimated cost a close examination reveals the cause, and if estimations are too low they can be corrected. If right, then a judicious addition to capable men's wages will tend to increase production, and benefit both employer and employed.

The governing principle is always kept in view, and this involves a knowledge of conditions; there-

fore the works cost of production, as a whole, must be consistently attended to.

Another safe plan is to examine the condition of every contract when two-thirds of the contract price has been expended. By such means a contract that has been overloaded by too much time on it may be put right during the remaining one-third finishing. This is keeping a hand on the reins and judging the means to reach the end in the time given, at the price agreed upon.

Works costs should be compiled, say, twice a year, to prove the correctness of any percentage value used. If a higher percentage than that used is found, the cause of increase must be traced to its source, and means must be taken to reduce it; because the usual percentage is assumedly an average that cannot be increased without destroying trade or losing profit. Neither is desirable, therefore a close examination becomes compulsory. Where works costs work out at a lower rate than the usual allowance, examination is just as necessary, because it may enable a better discount to be allowed and an increased volume of business, which tends to reduce the relative percentage charges, as the wages bill increases.

The daily correspondence is a necessary part of all good works management, and no needless delay should be permitted. Morning correspondence should be attended to promptly to give ample time for replies to be typed, and as the evening post hardly ever means excessive deliveries, they can be attended to without unnecessarily detaining the typists and others beyond the usual time of leaving off.

When this is attended to there will be no congested tables in the manager's offices, and the staff energies will be conserved to keep correspondence going during regular intervals.

However the conditions are reviewed the principle involved in the complete transactions, from start to finish, will never vary; therefore correct works management is really a science, based on a series of averages that measure out the complete organization over a given time, and custom has arranged this to be twelve months, or one calendar year.

The works have to do with invoices, and every invoice that refers to a works purchase should be sent straight into the manager for his signature. A good plan is to paste all incoming invoices into a loose invoice book, then send the book to the manager to initial all that can be passed by him. If any query arises out of the invoiced articles, the manager must attach a slip to the particular invoice, inscribed with anything he may suggest as an addition or subtraction; but in all cases a note, in red, on the bottom of the invoice will prove that such slip had been attached.

The duty of the invoice clerk is to enter the invoice as sent in, and to add whatever the manager's slip indicates. Thus a record is established, and in case of persistent carelessness or otherwise, the invoice book is a record of such, and it can be dealt with as required.

Another matter must be referred to, and that is that no verbal statement, unless substantiated by a written version, should be taken any notice of, because verbal statements either are forgotten or get so

garbled as to invalidate their value; besides it saves a large amount of friction and needless worry. Unless the organizer insists upon the observance of this rule and refuses to allow the least deviation from it, his best efforts may be destroyed, and this is especially true in regard to organizing a public company's works.

Humanity is often a contrary element, and where vested interests are likely to cause trouble a strict adherence to the rule that verbal statements are not binding will save anxiety, trouble, and perhaps scandalous assertions from doing harm.

Thus the principle of works management is based on ability, tact, judgment, and common sense, and where these are backed by determination and grit, very seldom will such a company fail to pay a dividend.

In the case of a public company the secretary will advise the manager as to the requirements of the directors in regard to matters involved in the "Companies Act"; but outside of this no interference with an organizer's method should be permitted, because, as an expert, he is the responsible person on whose back the responsibility of producing a profit rests.

In cases where the commercial side of the business is lacking in initiative, the directors, if wise men, will take the advice of the man who is the organizer. If they have no faith in his advice, they had better get rid of him and employ some one they can trust; otherwise the true principle of works management will be shattered and the end will be ruin.

The organizer is more than a superior servant, and more than a mere works manager. He is a profes-

sional exponent of correct management, and works on a principle that is a science of so much importance, that on it rests the very life of any manufacturing concern; therefore he is not only the leader of production but also the right advisor for the directorate to consult.

The subject cannot be pursued further on these lines, because it touches upon a sore place that irritates, but only for the time being, because the time is rapidly approaching when either deliberate interference with the profit-making of any concern, or a failure due to incapacity, will be considered a criminal offence, which the law will take cognizance of.

Generally, bad capital manipulation is due to a set of conditions which a pernicious custom has established, and the human element is at fault, more by its arrogant assumption of a knowledge it does not possess, than from an actual desire to pervert capital wrongly.

The natural trend of public business perspicacity is to remedy the things that the present law permits, and one of them is the right conduct of all manufacturing concerns, brought into being by the Companies Act; therefore the future of production will require good organization in works management, and all engineering students will do well to concentrate their attention upon a subject that has been for too long a period a source of wonder to the uninitiated.

CHAPTER XII.

THE MAKING OF AN ORGANIZER.

TRAINING is the first essential, but under the existing educational system the course is diverted; thereby students who may, in time, assume the rôle of guiding business destiny are divided into classes. Generally, primary schools, or those in which little more than the three R's are taught, scarcely afford the embryo organizer the necessary equipment for the serious duties an organizer has to perform. Fortunately such training does teach a lad to think, and to know the meaning of principle.

Whilst the secondary school pupil apparently possesses greater advantages than that of his more humble brother of the primary schools, in reality there is little to choose between them, except what is called tone, and that is not to be despised. Still, to teach a lad to think for himself is better than cramming him with thoughts and opinions of others. In the case of the primary scholar he is more likely to strike out a line for himself, governed by his knowledge of first principles, rather than by innumerable, though varied facts that have been demonstrated.

Educating a lad beyond the scope of the primary school serves a useful purpose, where the recipient

of the teaching shows ability in taking the ideas of others to measure his own by.

An impartial view of life undoubtedly shows that the primary school lad is handicapped in the race for position, not from inability to meet it if it came, but rather from custom and convention that array themselves on the side of the secondary branch to push them forward under more favourable conditions.

Any opinion that the writer expresses in this direction is, of course, his own, and open to question; besides, works management is not for the growing lad, though it is for the matured and prepared man. It may be said that schools of all sorts prepare pupils to comprehend theory, and the engineering universities attend to the demonstration of theory by practice; yet there is wanting the necessary accomplishment of being able to use theory in practice to the best practical advantage.

Technical schools have become a feature of twentieth-century training, and any lad so inclined can benefit by what the schools provide at a cost well within the reach of all, and the trend of the training is to get a practical acquaintance of manufacturing by personal manipulation, and by what expert teachers explain. But the best way for a lad to learn is as an apprentice to the trade he favours, but the mere fact of being an ideal mechanic will not ensure his being a capable organizer.

Engineering colleges teach good theory and apply such by practical demonstration. Yet the advanced student leaving such a college full of good information, and crammed with facts he has seen demonstrated, may not be any better fitted for the post of

organizer than the lad who has become a first-class mechanic through serving an apprenticeship to the trade.

It is too much to expect learned engineering professors to teach the science of management; but they might instil into their pupils the great advantage of good organizing.

It would be rank heresy to suggest that even professors of engineering science might make a hash if they tried to manage a works to produce a profit, unless otherwise specially qualified. The idea is not so far fetched as it may appear to be, because works management assumes a combination of special features that neither school nor college appears to teach.

Learned and able treatises have been written by men who knew what they were writing about; yet few, if any, serve the useful purpose of being valuable to the organizer.

Theory is the primary purpose of our colleges, and practical demonstration usually follows, but the relative cost paid for high efficiency in contradistinction to an average, is rarely, if ever, considered. Their object is to show how near practice can run to theory, and that serves a useful purpose, but it does not teach works management.

The efficiency of a machine in practice is limited to the sordid question of how much it will cost, whereas few organizers ever attempt to reach the ideal, but are content with an average, which they strive to improve with all their might. The highest efficiency of the organizer is that which costs the least, and when our engineering colleges begin to

teach that, then we are on the high road to economical efficiency. Generally, the limit imposed on college efficiencies is the one of available funds: when that has been reached they stop. Even the trials made in engineering matters are carried out under conditions very different to those of usual practice. They enable the best to be reached irrespective of cost, whereas practice wants the best average at the lowest cost.

Purchasers are as much to blame as sellers, because a purchaser accepts the plant at the guaranteed and proved efficiency, yet is content to get much less in practice.

Boiler efficiencies of 90 per cent are sometimes reached, yet the average is less than 50 per cent. Ninety per cent is phenomenal, but 50 per cent shows wilful waste. Under very usual conditions, but properly organized, an average of 70 per cent for such plants is possible and feasible.

Steam-engine practice has a maximum efficiency of 1 lb. of coal per horse-power per hour, but the average is fully 2 lb., or 100 per cent more.

The maximum efficiency of the gas engine may be 30 per cent, but the average is nearer 20 per cent, or less.

Generally, all along the line the organizer has a possible 20 per cent to encourage his efforts, and this is works management's duty, viz. highest efficiency at the least cost.

Ingenious contrivances are common, but they are isolated; yet there is generally a rush when a few reputable firms express satisfaction with the isolated results. But little in the nature of a persistent attack

on combined elements, such as found when manufacturing, is made, and where it is attacked by a capable organizer the result is marvellous, and the profit is enhanced.

Specialists have done good work in making the installation of works their study, and have left impressions of their genius, only to be obliterated in time by incompetent and incapable hands, or by crass ignorance. Fashion has induced many to get something another firm uses to advantage, because other conditional factors favour the installation; but rarely is consideration given to fitness or to the fact that where the conditions in one case are favourable, they may be unfavourable in another. In the first, the installation spells success, and in the other failure.

It is unfortunately too true that firms said to be very much up to date in their methods of production do see that some departments excel, leaving the majority jogging on with methods and machines that are long since out of date, and wasteful at that.

These various discouragements are all due to bad works management and poor organizing, and it is a pity that some isolated cases prove the advantage of good organizing whilst others show the contrary. It is a fair question to ask how the remedy can be applied, but the answer is equally fair and is as easy as the question. A discovery of the evils and of the way to destroy them is the task set before the organizer, and the fact that organizers know of the existence of the evils proves them to be the men to put right that which is wrong.

It is foolish to look for best results immediately,

but improvement should follow organizing, otherwise it proves its uselessness. Most problems, in production, are amenable to ability, if used with judgment.

Take, for instance, the installation of power in works, which is a factor of some importance when we remember what it costs to reach even average efficiency. Between the power given out by the engine and that utilized in actual production it is easy to reach a loss of 50 per cent, and in some cases more. With an average efficiency of 20 per cent in the engine, a loss of half of it, which leaves 10 per cent as useful energy, is bad.

Suppose twenty tons of coal are used per week costing £20, then 50 weeks = £1000, and 10 per cent is £100, showing that £900 are lost annually. If the organizer can save 20 per cent or £200 it is surely wisdom to spend £100 to get £200. But that is comparatively a small item, because saving 20 per cent of the power may add £1000 to output value. Another item is belting, which may mean an expenditure of £2000 per annum. Proper organizing necessitates giving attention to belts and increasing their life; suppose one-third of the expenditure can be saved, that means nearly £700 per annum. Therefore it is possible to save thousands by the judicious expenditure of hundreds where the organizer is capable; but such men cannot be said to be made, they are natural geniuses, and successful works management is carried out by utilizing personal initiative. Thus to produce an organizer a natural genius should be fostered, cultivated, and trained to give out inherent qualities lying dormant.

Another bar to paying results too often found in works practice arises from not knowing when to leave well alone. Experimenting blindly, in the hope that chance may reveal something, wastes money, and not experimenting when needed often loses money that might otherwise make all the difference between profit and loss.

Works management should be the most important factor in all organizations, but alas! its value is too often only recognized after an able exploiter of some system gets what he seeks—a sale. The foolish idea that exploiters of systems are peregrinating philanthropists must be discounted. They are out to make money, and the benefit given to the purchaser is quite a secondary matter. It does not alter facts even where cases are pointed out in which the exploited systems show good results, and it is not too much to assert that in many cases the same end could have been reached if the attention lavished on the system had been applied to the works before the system was introduced.

Take, for instance, cases where 50 and 60 per cent of advantage have been claimed for some apparatus applied to save power. Many such cases could be cited where only a small part of the additional attention demanded by the new apparatus, if it had been given to the neglected original plant, would have saved as much, and saved the cost of apparatus.

All these things form part of the organizer's duty. Every organizer should be sensible of the advantage of producing rapidly, and the use of powerful machinery to get the result is wise, yet reasonable judgment is required because a machine capable of

ploughing off material at the rate of 160 feet per minute, by the aid of some special tool steel, may represent a loss when compared with the same tool run at 100 feet per minute, showing economy both as to output and cost over a period of time for the lower speed, because the lower speed means better work and a longer life for the machine.

A visit to some works where high-speed production is forced to its limit furnishes an object lesson. One such case is remembered by the writer where a range of high-speed machines were run at their maximum speed, and similar machines of equal number were run at much lower speeds and formed part of the line.

The first were doing their best to wear out as fast as possible but their producing power was enormous; yet the slower-running machines over a time limit did more and better work at less cost than the others.

This does not mean that high-speed production is not to be sought, but it does mean that where high-speed production costs more over a time than an apparently lower production, it is bad management to force pace that does not pay.

To calculate production by mere speed measured over a short time is fallacious; because the production over a given time carries much waste and much depreciation; whereas the lower calculated production with less waste and a lower depreciation is the more profitable.

Works management, guided by reliable percentages that experience teaches to be sound, is cheaper than money used to produce weekly returns and

elaborate charts; the first brings success cheaply, and the other probably results in monetary loss. The man who is capable of organizing to a profit must be a rapid and accurate calculator; but he need not necessarily be a high standard mathematician.

A sound knowledge of metals in regard to wearing properties and strengths is needed, but the best equipment is a knowledge of men and how to handle them to get the best, because the human element is the paying machine of commerce, and all other things are simple aids to human genius.

In training works managers, it is wise to insist on the need for taking pains and not thinking any detail too insignificant for attention, in addition to a ready wit and a capability of tracing causes by their effects. But the greatest teaching of all is that an organizer should never have any fear of the prowess of the specialist whose knowledge and ability are used to the best advantage. The qualified organizer will always get credit from the specialist for being ingenious and capable if, when difficulty arises, the organizer locates the fault and supplies the remedy.

Any man who presumes to be an organizer, and fills his hands with detailed duties, shows that he is wanting in one great essential of works management —the ability to use others with advantage.

One man may be more capable than another, and where it comes to actual volume, the most capable may excel, but the limit is soon reached; whereas the born manager uses his knowledge to get a number of others near the mark of that in which he himself should excel.

In other words, he uses the abilities of others

because he knows what they are capable of doing. This is how works managers are made, and it outlines the kind of training they should undergo to fit them for the numerous duties of organization.

One of the great requirements of the age is business schools, where pupils are taught to command, and where, by intention, difficulties are forced into their path from which the pupil, unaided by any advice, should be able to free himself with the least expenditure of energy.

The teacher should be able to point out what was possible and compare that which the pupil did with what should have been done, and by such methods the pupil would anticipate difficulties and be the better prepared to overcome them.

With a series of difficulties met in an actual case by the pupil, and the best way to overcome them explained, experience is gained that will never be forgotten.

This shows the advantage of experience, and every one knows that the most intellectual training, unchecked by touch and actual experience, wanes with time; but actual experience lives, and similar conditions when they are met may reach some success, when the pupil anticipates what he expects to meet.

As already asserted, organizing is governed by principle, and whether it is engineering or farming the pupil who is forced to rest upon his own ingenuity in time of difficulty and succeeds best in overcoming it, or in meeting it fairly, is on the high road to make a good organizer.

But no mistaken ideas must exist that, because organizing is based on principle, one man is the best

to organize everything. The engineering organizer must be trained as an engineer, and the organizing farmer must learn farming, and so on.

Still it is a fact that the man who has learnt engineering is fitted, if an organizer, to arrange the best output for machines of any character; therefore it is not necessary for an organizer to be a specialist in the particular branch he undertakes the works management of, though it will aid him by making his task more easy if he is.

Commercialism has arrogated to itself possibilities of which practice shows it to be incapable. The general idea seems to be that the capability of carrying through some arranged system keeps a check on the producing departments to prevent irregularities. This is a great mistake, because it supposes the possibility of managing where the head merely takes what is supplied, and takes the figures as correct.

The futility of such methods is at once seen when the works people, if so inclined, can furnish figures that work out all right, whereas they are woefully wrong, being an unfaithful record of garbled factors that give an apparently correct result.

This commercial mistake has done a great deal of harm, but it takes time to prove it, even as it would take time to remedy the evil, if it was recognized.

This idea is responsible for elaborate weekly and monthly returns that are merely aids to want of knowledge, and even when supplied, are probably not understood. It is imagined that their very production tends to keep responsible officials up to their duty, under the impression that their doings are tabu-

lated and arranged up to date. This is a grievous error, because the works officials, though they may be bad organizers, do know something of their work, and of the impossibility of a non-practical man knowing anything that can interfere with unbusiness-like doings, if the works officials are inclined to indulge in them; therefore the money spent in producing useless returns, if employed in the business, would lead to a profitable end. The end cannot be reached until the proprietors or directors see the need of a capable manager, who is paid according to his worth. In other words, the works organizer may be a poor commercial man, but the commercial man is usually equally a poor works manager. A works manager and a commercial manager are needed, but neither should be able, under the powers vested in them, to interfere officially, though they should advise each other frequently.

Even on the chance of being misunderstood, it must be asserted that where the works management is in the hands of an efficient organizer, it is necessary for the welfare of the business that every detail affecting the ultimate end should be open to the organizer's inspection; otherwise his efforts will be crippled by want of knowledge.

It is useless for works management to spend time and energy to save 5 per cent if the commercial side of the business wastes 10 per cent to find out how works management does it.

Confidence in management is essential, and where that cannot be given, new management that can command it must be installed in place of the discredited official.

Every person connected with any business must learn that capital must be kept intact under even the worst conditions, or bankruptcy will be the end, either early or late.

Works management is a high art of a most intricate nature; but the making of a works manager who is an organizer is beyond the power of anyone, though it is possible to aid the efforts of a good organizer, and even the smallest boy employed can do that.

Proprietors or directors are well advised to get the best man money can induce to undertake the duty of works management, and failing at first to find the right man, they must patiently persevere until they do.

The same applies to those the manager employs—he must seek the best and pay them accordingly, and as a result his efforts will win success.

As the competent organizer leaves little to memorize, so data, of a useful nature, are needed to make such a work as this complete; not as a vade mecum of detailed information, but rather as keys to a more extensive acquaintance with all that refers to every detail involved in production. For which reason the following chapters are compiled.

CHAPTER XIII.

THINGS THAT THE ORGANIZER MUST KNOW.

If any reader imagines that the writer decries learning as an unnecessary equipment to works management, a mistake has been made. Education is a most desirable adjunct; but if it is thought that learning alone, even of the highest order, will make the successful organizer, a still greater mistake is made.

Whilst the illiterate would be seriously handicapped in the race, even in one with the genius of organizing fully alive, still it is a matter that perseverance and time would reduce. Some learning is necessary, and without it the greatest genius would make little headway. This is not the place, neither is it the intention of the writer, to describe the extent of learning required; enough to say that neither excess of education nor its want of it is to be advised; but just as education without genius would be of little use in successful organizing, genius without some education would be as useless.

Works management needs intelligence of a high order, and intelligence is fostered by educational advantages, properly applied; therefore the organizer must know many things. He need not be a detailist, but he must possess concrete knowledge, and be able to use it as required to aid others to understand, and

it is especially true in regard to engineering where it is difficult to say what is and what is not essential knowledge.

He must know something of the many things that go to make up the whole of his experience; starting from installing a works to the final production of the article the works is intended for, and such experience involves much needful intelligence that education alone provides for; therefore education is essential.

It may appear to be paradoxical to say that the organizer must have more than a little knowledge of the commercial side of a business to be able to organize efficiently; but it is nevertheless true, and this includes buying and selling to the best advantage. No one can buy or sell satisfactorily unless they have some knowledge of the fitness and quality of the articles they handle, and constant dealing in such adds to experience, and experience increases knowledge; therefore experience is a valuable adjunct to other good qualities.

Materials, their values, strengths, and suitability for the purposes intended must form part of the organizer's repertoire, otherwise he will be left in the hands of another and his value will decline in proportion.

A collection of data forms a good equipment; but it is discounted if the possessor knows nothing of the means whereby the data were obtained. Custom and extended use have resulted in our accepting certain arbitrary dimensions, and rules deduced from experiment for similar conditions are provided, and can be used to enable the organizer to determine

values for variations of magnitude, volume, or number from the standard conditions.

This can only mean that both theory and practice are constantly needed by the organizer.

In an early part of this work it was assumed that a works is established and orders are in hand needing production to fulfil them, and as production is the end of all works installation, anything and everything that can ensure a regular and certain production, nearest to the ideal character, is what the organizer must meet by acquiring an all-round knowledge.

Production requires material, but materials vary enormously, not only in character, but in quality; quality is due to some characteristic, and that must be known.

The commonest material is the metal obtained from ore dug out from the earth, and separated from all earthy matter by fusing the ore in a furnace; but the class produced rests upon how much of alloy is introduced or is associated with the metal, which is run into moulds, the casts being termed pigs; hence the name pig-iron, which is cast-iron and is the most common of all the metals used in production.

Cast-iron is stocked under numbers, and fortunately one class is known from another by appearance; but the smelter does not rely upon appearance alone, for the chemist analyses a sample, and decides the number that the quality represents.

Such metals range from a scintillating, silvery-looking grain, which is a hard material, to a grey or softer metal; but between the extreme colours there are grades of shade, and the chemist knows that the

greys are due to graphite, which in combination with the white grains produces the colour. The greyest is not nearly so strong as the white, therefore most castings are produced from a mixture of greys, grouped, say, into light grey, medium, and dark, and these vary in strength according to their numbering. Light castings require a less quantity of No. 1 than heavy. Indeed, as a rule, as castings increase in weight the mixture contains less and less of No. 1.

The silvery grained iron is low in carbon or graphite, and is used for the production of the bar-iron of commerce. One property of the grey cast-iron is its greater fluidity, and the capability of slightly expanding when cooling, thereby giving a clean and even appearance to the skin of the article produced from it.

With such knowledge the organizer is able to provide for the most suitable material to produce the best results at the least cost, because it ensures fewer failures.

When a molten metal is poured into a mould its bulk is greater than when it solidifies, therefore shrinkage must be provided for; but experience is necessary to ensure best results, because a thin casting shrinks less than a thick one. Some castings shrink $\frac{1}{4}$ inch per foot, whereas others contract $\frac{1}{8}$ inch or $\frac{1}{16}$. Very usual practice allows $\frac{1}{10}$ inch per foot; but long experience is the best teacher to prevent failures from excessive shrinkage, and the patternmaker is the one to prevent failure, by arranging his patterns to suit different shrinkages.

The curved arms of pulleys are made so to prevent fracture due to shrinkage, the boss cooling last,

and intricate castings in which different sections cross each other need very careful handling to prevent breakages due to internal stress.

The pattern-shop foreman and foundry manager will see to these things if they are capable men; yet the organizer is better equipped for his task when he knows the causes that produce results.

Experience also teaches him that cast-iron is an unreliable metal, and he allows for this by leaving a big margin of strength.

The avoidance of sharp corners and sharp-angled hollows the veriest novice knows to be wise; yet the neglect of such simple things and non-attention to the effect of unequal shrinkage, often occasion enormous losses by broken castings.

Wrought-iron and steel, as commercial articles, are usually the production of specialists, and the works manager need not trouble himself with their production, other than to know that the best irons are always the dearest to purchase, but, generally, they are the cheapest to use.

It is a wise thing, especially with steels, to deal with one reliable firm, and when special steels are required for particular purposes, an instruction to the firm will always receive attention, and any advice required will usually be forthcoming.

Without treading on debateable ground, it is yet a wise thing to assert that no material should be stressed beyond one-third of its ultimate breaking stress, and the reason is that a most usual limit for elasticity is one-third of the breaking stress. With such rough knowledge a failure in any machine is avoided.

Sometimes it is necessary to impart malleability

to cast articles, and this is attained by surrounding the casting with red hematitic ore and keeping it at a great heat for a long time, which varies with the size of the casting. The effect is the elimination of carbon which brings the metal into a condition similar to that of wrought-iron. The resemblance of malleable to wrought-iron may only be partial, yet it imparts ductility and makes the casting capable of withstanding severe shocks without breaking.

Case-hardening is another operation to which metals are subjected, where a hard surface is required when metals are exposed to shocks; either wrought-iron or steel can be made surface hard, leaving the other parts under its normal condition.

Prussiate of potassium rubbed on to a hot surface which is afterwards plunged into water slightly case-hardens the object to a very little depth, but sufficient for many purposes. Other means are needed where extra depth of hardness is wished for.

Case-hardening has become quite an art, and many specialists exploit plants for the purpose. The speciality has been of great advantage in hardening small tools, enabling large quantities to be hardened without the disabilities attached to the old methods.

Various degrees of hardness may be required in one tool: some parts are required dead hard, and others only hard enough to stiffen the material. By luting surfaces carefully, that is, clothing the parts in non-conducting material, such parts can be left soft and ductile, whilst the parts needing hardening are brought into contact with the hardening compositions, and heat of a standard temperature completes the operation.

Temperature is important, because a few degrees above or below a given heat makes all the difference between good and bad hardening. There are many different classes of steel, and each seems to require one particular temperature to ensure equable and good results.

This is another department where loss can easily occur, and employing merely handy men to do work requiring skilled attention is the easiest way to lose money.

The organizer needs only a general knowledge, but if he has a specific understanding of all that pertains to the hardening shop, so much the better. Still a specific expert knowledge probably indicates a lack of it for some other branch; and an all-round knowledge of all departments is superior to a specific or even expert understanding of only one.

Brass and gunmetal castings are common to a general engineering works, but their manipulation is best left to experts, yet a general knowledge is good for the organizer.

Mixtures of 8 to 18 of tin to 92 and 82 of copper are used, the first is for soft gunmetals and the latter for hard, whilst brass usually means a mixture of say 66 parts copper to 34 of zinc, and frequently a little lead is added.

Gunmetal is largely used for bearings, and judicious mixtures of copper and tin provide a good bearing metal of low frictional resistance. In these days of fast speeds phosphor bronze bearings are common, but experience teaches that under excessive pressures and hard wear the phosphor bronzes of commerce laminate on the surface, and that often causes trouble,

whereas hard gunmetal, if chilled, has its tenacity increased and its homogeneity bettered, and in the opinion of the writer there is less loss attending the use of hard gunmetal than of phosphor bronze. On this subject opinions will differ; but the organizer wants the surest material to produce the best result at a given cost; therefore he must be able to judge of the merits of material by the results attained.

In regard to factors of safety, works management may do much to save material without destroying excellence, and reap the reward of increased profits.

Wrought-iron is usually a very safe material under one-third load, or where shocks are common an increase to a factor of safety of 6 is wise, whereas with steel, not being so reliable, the factor should be 8. For cast-iron subjected to shocks, a factor of 9 may save expense at the end.

The effects produced by dead and live loads are very marked, but generally, all running plants involve vibratory movement or shocks.

A very usual plan and a fairly safe one is to give a factor for all cast-iron of 8 and for other parts 5; this will be found economical in material, while providing ample strength, which is an insurance against breakage. All these are things left to the judgment of the organizer. It seems too obvious to need attention here, yet it is mentioned that wrought-iron is strongest under tensile strains and cast-iron under compressions.

Another matter that cannot be neglected, and unfortunately is too often forgotten, is that metals get tired like human beings, and unless attention is given in time a serious breakdown may occur.

Anything kept under a constantly varying stress will tire in time and give way; therefore chains, bolts, and screws should be attended to at definite periods to prevent disaster. Fortunately a simple remedy is at hand whereby the tired feeling on a metal is destroyed, and its original strength is regained. Annealing is the remedy, and if attended to at regular intervals fewer accidents would occur, and human life would be safer.

The organizer sees to these things, and finds that it is cheaper to pay the cost of annealing a part than reinstating the complete apparatus.

Running machines day and night soon brings on a rapid decline in efficiency, much beyond that produced by a lengthened period of running with regular intervals for rest. Machines are very like human beings in this respect, they want rest, and unless they get it they will soon subside under the continued burden.

These are a few of the things the organizer must be educated in if he wishes to excel in his office.

It seems foolish to speak of lubricating, yet it is possible by attention to this apparently trivial matter to either enhance or destroy the best efforts of works management.

Many firms point with some pride to the fact that their yearly oil bill has been reduced enormously by using a cheaper oil which appears to be just as good as a dearer one.

It is well known that the wise use of oils helps production very much. A thin oil for a light load and a thick oil for a heavy is generally acknowledged to be right. But we must take care that a thin oil

is a good lubricant, and that a thick oil is not thin oil faked.

In oils, as in other things, the best costs the most to buy, but it may last the longest in use; therefore the dearest to purchase may be the cheapest to use. A thick oil will stop a watch, yet the oil suited for a watch will stop a big machine.

Viscosity means body and sticking capacity. Many a thick and apparently viscous oil will run like water if subjected to a little heat, which proves its uselessness for a heavy load whose frictional resistance engenders heat, whereas a thin oil may show a much greater viscosity at the same temperature.

A low coefficient of friction in a running plant adds to the profit. Where it is possible to reduce the coefficient from ·032 to ·016, whatever the cost due to the first, it is only half if due to the second or 50 per cent of the loss has been saved, because the frictional resistance has been reduced one-half.

A very simple lubricant testing machine, costing little, installed in every works is economical, because it would show what oil to use to get the best out of any machine.

But good oil must have the opportunity to act, and a very simple test will provide much knowledge. Provide a bearing and a journal and subject the journal to pressure, taking say 1 inch of the bottom part of the bearing as a test width, that is $\frac{1}{2}$ inch each side of the centre. Under a given pressure perhaps only one oil will form a film between journal and bearing under the pressure. This is a proof that the pressure cannot force out the film of oil, and is also

a proof that the journal is in contact with oil and not with the metal of the bearing, and the coefficient will be the difference between metal and metal, and metal and oil, and that may be ·10 and ·18, or 45 per cent difference. This is a proof that the use of oil is discriminative, and by judicious choice the management will increase output, save power, and add to profit.

Another simple reminder is that a turned shaft working in a bored hole only rests upon the bottom, otherwise it would be a close fit and would not work. With this pertinent fact before the mind the organizer should see that sufficient room is left for a film of oil to separate the two metals.

By clearing away the sides of a bearing for one-half of the circumference involved in two opposite positions, a space is left for an oil reservoir, and the wiping of the shaft on the surface of the oil retained in the reservoir ensures a film being always in contact with the journal and bearing when resting one above the other; that is, of course, where the oil is not squeezed out by the pressure.

Too many such references may seem foolish, because all are supposed to know such things; yet a visit to most works and an examination would show that these simple things are too often neglected, and as a result profits are lost, or means to increase profit are neglected.

Therefore successful works management necessitates not only knowing things, but doing them, or seeing that they are done.

The Scotchman's plea that "every mickle makes a muckle" is absolutely true in organizing, and many

small things saved make a total that makes the difference between profit and loss.

The man who loses touch of the reins can never guide his team to victory, neither can the man who fastens up his reins win the race; but the man with the reins between his fingers and his eye on the team takes advantage of every move to get an advantage and loses nothing by going the longest way round; but he makes sure that the course he is running is safe, and though he expects difficulties, he is ready to meet them. So it is with works management, the manager attends to the simplest things, or rather he sees that they are done, and time and money are saved and the race is won.

One more apparently foolish reminder is the necessity of a clean shop, and especially clean machines, not merely at the end of the week but all through it.

The harder a machine is worked the more the debris to be cleared away. Generally, articles have to be set and fixed, and removed when machined; therefore the less time the operator spends in clearing away, the more time he has to keep the machine fully fed.

Every hour spent by the operator means, say, 9d., whereas the same time spent by the cleaner up is 6d., or 3d. per hour saved. But more than this occurs, because the output of the machine may be increased 10 per cent, and that means much more than the difference between the men's wages. It means 10 per cent of the dead expenses referred to the machine saved per week, and that means much.

Unless a man recognizes these facts they are not likely to be utilized. Endless savings may be

effected, but they must be recognized as possible, otherwise they are lost through ignorance.

It may seem as if the organizer has a hard time of it; but it is only apparent, because the better the organizing the easier his task, and whatever he is paid for it, it is worth the money, as profits are added perhaps by hundreds, whereas his extra salary is only counted by ones.

CHAPTER XIV.

THE VALUE OF KNOWLEDGE.

Some old-fashioned country folk have an idea, which was once very prevalent, that the gracefully curved handle of churn or grindstone was easier to turn than a straight one, and it would be hard to convince them otherwise. To tell them that the straight line drawn from the centre of the part the hand grips to the centre of the axle represented the leverage, and that no amount of curving to the handle could alter it, would be met with the statement that all the talk in the world would not alter the fact that the curved handle is easier to turn than a straight one.

We know that no amount of curving can alter the leverage, and that it is just as reasonable to expect a corrugated piston top to present more active area than a flat one; yet in much of the so-called works management of the day a roundabout way, with many twists and turns, is thought to be the best to reach a financial end.

The student of engineering will probably say that it is childish to waste space to speak of things so obvious; but they would not be so censorious did they but know the lot of nonsense some very able engineers talk at times. It is because of such experi-

ence the present, apparently, foolish references are made.

James Watt, when proposing a means of computing the power his engine gave out, gauged it by what a horse could do. He was aware that if he gave the maximum power a horse could do many would cry "nonsense," yet if he named too low a value many would assert that to their own knowledge they knew many cases in which a horse had done better; therefore Watt, in his wisdom, resorted to an average. Human nature to-day has more experience to fall back upon than the folk in Watt's day, yet human nature still has its idiosyncrasies.

Nominal horse-power, as originally understood, had no relation to the dimensions, but it had to what a horse could do; yet dimension was given to it, and it continued to be a commercial gauge until the dimension began to represent six times the original. Nominal horse-power still exists because it is hard to kill old notions. Horse-power at that time referred to definite factors, but when such factors were altered, resulting in an increased horse-power from original dimensions, the term nominal became valueless as an indication of possible energy.

Even to-day, when the indicated power is the commercial value, it does not give the true power, because mechanical efficiencies range from 60 to 90 per cent. In somewhat similar fashion works management of to-day cannot be measured by the methods of the past. To-day, perhaps, six times the work is done at one-third of the original cost; therefore to use old methods to calculate out new ideas is absurd.

The laws of friction, in spite of untold experiment, remain a doubtful quantity, resulting in innumerable problems that now and then are so startling as to upset standards that have become part of the common faith. The capable organizer, when he comes across problems that show an advantage above what ordinary practice reveals, tackles the case, and by tenacity of purpose and ability frequently gets an advantage which increases efficiency sufficient to better the profit.

Like frictional effects, assumed to be independent of surface, works management is apparently independent of magnitude; yet we know of a certainty that magnitude reduces the indirect expenses, so practice shows that the drag against progress is reduced.

Many such analogies could be referred to where problematic results are unexplainable by any known law. In this way and with such things the organizer who is fully alive to his duty often gets results that astonish experts.

The ability of the organizer is often directed to daring attacks on customary and conventional methods, and in spite of learned arguments that the bourne cannot be reached, he often gets there, and astounds the arguers, and discredits many a learned discussion.

As an object lesson in support of the suggestion, it is well known that dipping a hot piece of steel into cold water hardens it; but it is little known that a similar operation will make the steel softer than any other method can.

Thus standards that produce a given result will

often give contrary results by a little management; therefore management is largely a method of knowing how.

A reminiscence of a simple character goes to qualify the statement. The case was one in which certain parts of a machine, or rather machines, broke, and the blame was put on the steel used, whereas it was caused by running the machine beyond its guaranteed speed. The steel was right, but the user was wrong. Unfortunately the user prided himself on his knowledge of metals, and especially of steel; therefore tact was required to show him his error.

A bar of steel was broken into a number of pieces under varying conditions, which gave as many varying appearances to the fracture, and these were put into a block of blackened and varnished wood, and the whole was covered over.

The complainer, with the aid of a good magnifying glass and long scrutiny, decided upon one piece and said that if the broken parts were remade of that steel and it broke he would pay double the price; if it did not break he paid nothing.

The man's astonishment was great when the smith was called in who prepared the pieces and was left with the complainer to be questioned. When he was told and convinced that the piece he had been at such pains to select was only off the same bar as the others he passed over, he apologized for being so bumptious.

This was managing a difficulty expertly, and it made money, because the new parts did not break; but the machines were reduced to guaranteed speed, and the complainer paid the piper. These are a few

of the things worth knowing, viz. that different conditions produce effects independently of the material used.

Every one knows that water will not run up hill, but it can be forced up, but only by using more power than the actual work done upon the water. Neither will production go on by itself, yet any attempt to hustle will merely waste one power to get only a small part of it as useful. This is an inevitable loss, and one of the lessons works management must learn and cannot neglect. A steady, even flow gives a better delivery than a forced, spasmodic pushing, besides costing less.

It is well to know that increasing the velocity of flow must be paid for, because frictional resistance is increased, and where such resistance increases as the square of the velocity, the greater velocity requires power in proportion, and where the power used is extravagant for the extra discharge the result is not economical. To get the best result requires knowledge and the exercise of considerable judgment, and a useful lesson is learnt when it is known that hustling does not always mean adding to the useful result.

Often enough increasing the volume of production by forcing, decreases the total value by increasing waste.

This brings in the question of the advantage, or disadvantage, of high speeds.

Every machine can produce good work at a given speed that is most economical, anything beyond it will increase wear and tear which will induce the production of bad work, and inevitably cause money

losses; but it needs wisdom and judgment to strike the happy mean.

Some works management may be likened to punching holes in a plate that is thicker than the diameter of the punch. It can be done, but it is not economical, and experience teaches the lesson that the best steel punch is only economically capable of punching a hole through a wrought-iron plate equal in thickness to the diameter of the punch. This can be done without needing excessive care, and is fairly economical.

Suppose a business is paying 5 per cent, and it is desired to make 10; if it costs 5 per cent to get the increase it is sheer nonsense to attempt it, because the estimated extra cost of 5 per cent may easily mean 10 per cent; therefore in trying to get an extra 5 per cent the ensured 5 per cent may be lost. The capable organizer will traverse the whole ground and examine every item of expenditure likely to produce the desired increase, and this review would perhaps show many leakages, the stoppage of which would easily give the required 5 per cent at relatively no expense.

Something, and even a great deal, must be known of various depreciations, and it is good to have what experience teaches at the finger-ends to gauge results better when reached. Already a number of useful factors have been given in regard to the percentage additions (though merely arbitrary) required to be added to wages to cover the indirect expenses of various departments. Depreciation is included in such expenses, but its separate value by reference to plant, etc., involved is worth knowing.

Depreciation of buildings varies with the class, and flimsy structures always depreciate faster than solid buildings. Depréciation may range from 2 per cent for the solid to 7 per cent for the flimsy.

Works in which vibration is frequent depreciate more rapidly than where vibration is absent.

Forges are subjected to many miniature volcanic disturbances, and it is well to depreciate as much as 9 per cent.

Foundries may depreciate 7 per cent, or equal to flimsy structures; but the organizer will strive to reduce the values by putting in extra good foundations, which is wise, because the capital value is recoverable over a longer period thus reducing the indirect expenses account and adding to profit.

Plant depreciation rests largely upon the organizer's ability; but it is always well to bear in mind that actual depreciation, and not imagined, is what is required. A true depreciation may give the more accurate gauge for profit.

A favourite depreciative value as an average is in the region of 10 per cent, but it matters not how carefully depreciation is attained, a re-valuation every seven years is necessary and advisable.

Engines and all power appliances suffer depreciation rapidly; sometimes 7 per cent is deemed sufficient, but 12½ is the more likely, this including boilers, etc.

It has already been argued that all repairs to plant should be added to plant value, and the total value would suffer depreciation in due course: repairs to buildings should be dealt with in a similar way.

To ensure safety in working, especially in these days of active Government Inspectors, needs care and attention, and no organizer neglects that which is both good for humanity and necessary to good business.

The power element cannot be too well supervised, and in the case of boilers and engines, insuring with a good company is cheapest and best, because most firms using large elements of power are usually intent on getting a profitable outcome, and they are likely to neglect unlikely contingencies that need close attention.

Experts, who add to it capability, too often have their hands so full that it is well to have an outsider to guard them against themselves, because their knowledge may become a danger and menace to others. In other words, familiarity breeds contempt, and too much reliance upon accurate knowledge often brings a fall; therefore the official examination of power plants by outsiders, though it means money, may be a saving in expenditure.

Another matter in which knowledge is desirable, though not essential because it refers to the foundry, which the responsible head is not likely to neglect, is the amount of metal required for a casting.

Roughly, a square foot of cast-iron 1 inch thick weighs about 38 lb., but it is usual to allow about 2 lb. for scum; therefore 40 lb. per square foot for 1 inch thick, or 5 lb. per square foot for every $\frac{1}{8}$ inch thickness, will ensure ample metal to give a full cast.

The strength of materials is another thing worth knowing; not actual strengths, but ample strength to ensure safety for lifting tackle, etc., whose failure

is the cause of many accidents in works. Strength of ropes and chains are usually referred to in useful tables, but the organizer should carry in his mind safe strengths, whereby many a dangerous moment is changed, by knowledge, into certain safety.

A one inch rope and $\frac{1}{4}$ inch chain are two convenient dimensions to remember. Ropes are usually referred to the circumference, and 3 inches is roughly the dimension for 1 inch diameter, and a safe load is 10 cwt. though 15 is usually given. The 10 cwt. load is wise because ropes in common use get strained, stranded, and become fatigued. With this knowledge the size of rope required for a given weight is readily ascertained.

In a similar way a $\frac{1}{4}''$ chain, $\frac{1}{4}''$ being the diameter of the link iron, is safe with a load of 5 cwt.

It is good practice to have all chains carefully examined and annealed every three months, and all ropes overhauled at equal periods; besides it will pay by saving accidents that destroy material and often endanger life. These examinations cost little and save much, besides saving worry and anxiety; and an organizer will see that they are attended to, because it is part of his method of reaching a sure finish.

To say more in this connexion would suppose a purpose different to the present, which is works management, and not a works manager's book of reference.

The student whose desire is to enter the enterprizing field of works management will find it an advantage to have an example before him, no matter how imperfect, so long as it is practicable and reasonable. To meet this very necessary object lesson an

example will be furnished in the ensuing chapters; but students are warned not to take the example as one to be followed throughout, but as one in which the principle of works management is put into something like practicable shape. It will be merely possible to briefly outline a very extensive field to be explored, which the previous chapters have anticipated; yet it will indicate the course, which the industrious student will follow, and as a result a reasonable end will be reached, and during the progress of detail consideration much useful information will be gained that may form the beginning of better works management than many have considered possible.

To attempt anything more would require a book much larger than this, and probably the advantage gained would be little; because works management under good organizing is not so much a matter of what has been done as what can be done, if attacked by the right person: therefore the following is just a rough guide to a way in which methods may give rise to better results.

Those who imagine the task to be greater than the ordinary person can tackle may at once cease to desire a position which apparently bristles with difficulty and necessitates hard work; but those who still determine to push forward will be surprised how difficulty wanes, and that which at first seems nearly impossible, soon begins to look easy, and as interest gathers the romantic nature of the task glamours, urging the seeker to push ahead with more vigour and even greater eagerness.

The reminiscence of the Manchester Exhibition is well worth remembering, because tracing one set of

operations throughout revealed the fact that the complete machine was made up of a number of similar details, amalgamated, and it is so in works management. When the principle is fairly grasped it is seen that the magnitude dissolves into a multiplication of simple facts, rather than an aggregation of unending, variable items.

The advice afforded to all embryo works managers is to get at it intelligently under the full belief that you may be able to do better, and if you feel so, and back it up by zeal and painstaking effort you may depend that you are on the highway to do better than you have ever done before, and the thought that you may be able to bring order out of chaos and make a paying concern of a losing one is something to strive for, that which will bring both credit and honour.

What the writer asserts he feels, and moreover, he has proved its truth over years of experience, and the feeling that something has been well done is a satisfaction that nothing in the nature of personal emolument could provide.

It has been said by the writer that works management is romantic, and that is true beyond all question, because many imaginary factors have been realized unexpectantly; whereas far more dry-as-dust systems that pretended much, and gave little, have faded into obscurity.

If the succeeding chapters do what the writer hopes they will, then a step in the right direction has been taken, and many a failure will be made into a success, and both nation and people will benefit; because pure business is the soul of a nation and acts well for the welfare of its people.

CHAPTER XV.

STARTING A NEW ENGINEERING BUSINESS.

THE first consideration is available capital, and whatever its value, if placed in a bank it would carry 2½ per cent interest. Instead of doing this the holder of the capital seeks more interest than the bank can allow, and to reach the end it is invested in a business, where the turnover may result in a greater profit than the bank can give. This is the primary object of all manufacturing works.

Land.—The first matter to receive attention is land, and assuming that other and similar factories are in the neighbourhood it may be taken for granted that transit to and fro is reasonable. With the intention of extending the business as opportunity offers sufficient ground is acquired, and this is found in a lot of 400 × 400 feet = 160,000 square feet. Suppose the price paid for the freehold is £12,000; such a price under the conditions is fair, because it will accommodate 810 houses, each occupying 2000 square feet which would bring in £7 10s. per annum each, or £600 per year, and if capitalized over twenty years it makes £12,000. The figures are merely arbitrary, yet they are approximately close to that which practice warrants. Now, £12,000 is sunk or invested in that which will ensure its return when

wanted, but interest is expected from the capital so invested equal to 2½ per cent; therefore the interest is equal to £300 which is a first charge on the revenue that the production may bring.

Suppose the available capital is £150,000, and this less £12,000 leaves £138,000 to be otherwise employed. As an arbitrary division suppose the available money is divided into three parts one of which is sunk in building, another in plant and tools, and the remaining third is reserved for working capital. Assuming that £46,000 is put into building a sound works the life will be easily fifty years, and this means a yearly recovery of £920. If this £920 is taken out of revenue every year and banked, in fifty years the original capital would still be intact; therefore 2½ per cent is obtained annually on the original value.

Generally, the yearly withdrawal from revenue is not banked, but is used to extend the business, therefore the capital remains intact in the business though it suffers apparent depreciation annually, but as it is appreciated by an equal amount, the original capital invested is that on which 2½ per cent interest has to be paid.

Though the buildings are depreciated 2 per cent equal to £920 per annum, extensions to an equal value keeps the original capital intact. The interest is £1150 + 300 = £1450 for capital sunk in land and buildings. But another £46,000 is sunk in plant and tools which may have an average life of fifteen years, recoverable from revenue at the rate of £3066 per annum, equivalent to about 6·6 per cent depreciation, but 2½ per cent must be allowed for

interest. Presuming that appreciation is equal to depreciation, then 2½ per cent interest on the total capital is needed, where such capital is kept intact in plant and tools. The working capital is supposedly another £46,000, and the first charge upon its working is say, about 8·2 per cent to cover 2½ per cent interest on the total capital of £150,000.

Working Capital.—With such a capital, brass and iron-founding is not included, but the requirements of the business can be met by purchase from specialists. Outside of these two all other departments must be provided, and anything in the nature of useful information in regard to them, even if only rough approximations, are welcome to the organizer.

Whatever the department, it must bear a proportionate share of the indirect expenses, and extended practice allows that the following divisions are very close to what are actually common. Dividing the indirect expenses into ten divisions, we get the following proportions:—

Drawing office	equal	$\frac{1}{16}$ of	1 division
Stores	,,	$\frac{1}{16}$ of	1 ,,
Pattern-shop	,,	$\frac{1}{8}$ of	1 ,,
Smith's-shop	,,	$\frac{3}{4}$ of	1 ,,
Machine-shop	,,	5 divisions	
Fitting-shop	,,	1 division	
Erecting-shop	,,	3 divisions	

These proportions include works, offices, etc., etc., and each bear a share in paying off indirect expenses.

Wages paid for skilled labour generally includes the labouring assistance skilled labour requires; therefore the wages bill forms a base for any volume

of business, because no wages bill means no production, whereas a large wages bill presumes a voluminous production.

The working capital is not all available for wages, because material has to be paid for, but every penny, however expended, must be made out of the use of the working capital of £46,000 as assumed.

This is the time to draw attention to a most important factor in all works management, and attention to it cannot be called too often, because it is the saving factor in engineering finance; the point is the number of times the working capital is used in one year. In the present case if only used once, probably 480 per cent on wages would be required to cover the indirect expenses; whereas turned over four times in the year 120 per cent on the assumed working capital would be enough, because £46,000 used four times in the year is equivalent to £184,000 used once in the year. By the use of a small capital turned over frequently the interest is in proportion; for the case stated the interest is only on £46,000, and not on £184,000; or only one-fourth. Three-monthly accounts may not be possible sometimes, but that is met by permission of the purchasers to draw at certain stages of the works progress, and that is equivalent to the other.

As an example, suppose the capital available is ample to allow £197,600 for working per annum, leaving the other items as a proportion as before, the assumed capital required would be £395,200, and the sum of £9880 would be required for interest; whereas on £197,600 it is only half; therefore a small working capital turned over frequently means a low

cost for production whilst keeping up the profit advantage.

Taking the assumed working capital, per annum, as £197,600, it must be able to earn sufficient to cover 2½ per cent on the invested capital, plus bad debts, etc.

Suppose the capital is £144,600—of which £49,400 is reserved as working capital—which is turned over four times a year.

Now, 2½ per cent on £444,600 = £11,115, and 5 per cent for bad debts, etc. = £22,230, and add 7½ per cent—the desired profit = £33,345; making a total of £66,690, which a working capital of £49,400 must earn. If only used once in the year the percentage of 135 would be required; but used four times a year the quarterly rate is 33·75 per cent.

Suppose the capital is only turned over three times in the year, the same total value must be earned; therefore the true working conditions must be referred to the respective assumed capital: or £197,600 when the actual is used four times, and £148,200 when used only three times. In the one case £66,690 refers to 33·75 per cent, and in the other to 45 per cent, which must increase the value of the goods to the customer; therefore using the same working capital four times in the year gives an advantage of 11·25 per cent over that when it is only used three times; therefore turning over capital quickly is good management.

But a more difficult task is to ensure the end by seeing that the stages to reach it are adequate, and the working capital is the material out of which the bridging is done. Suppose, £100,000 of £150,000 is

sunk in land, buildings, plant, and tools, £50,000 remains as working capital. Now, £50,000 may be turned over four times per annum equal to £200,000 used once a year. But £50,000 must produce the required result.

Basing the value of indirect expenses on 120 per cent of the wages paid, and allowing a per cent value of the gross invoice to cover 5 per cent profit, and another value for bad debts, etc., a proportion can be arrived at.

Taking a very usual factor of 40 per cent of the wages paid as the value of material used, plus the 120 on wages for indirect expenses, plus wages, etc., a basis is found for a division of the gross invoice charges, as follows, for a turnover of £236,194 per year:—

To cover	interest at 2½ per cent	take	3·2 per cent	= £5,904
,,	bad debts, etc.	,,	5·0 ,,	= 11,809
,,	material	,,	12·6 ,,	= 29,760
,,	wages	,,	32·4 ,,	= 76,527
,,	indirect expenses	,,	39·2 ,,	= 92,588
,,	depreciation	,,	2·8 ,,	= 6,614
,,	overdraws, etc.	,,	4·8 ,,	= 10,392

or practically the whole value, or if correctly worked out, plus 1·1 per cent profit.

The division is only approximate for an assumed engineering works, and will have different proportions for another, which would be considered.

Whatever the turnover may be, depreciation and the profit from the whole of the invested capital must be earned, and indirect expenses still stand at 120 per cent on wages for the supposed conditions.

The per cent proportions for material, wages, and indirect expenses are merely arbitrary; it is pos-

sible that wages may be more than 32·4 per cent and material less than 12·6 per cent, but where wages are high the per cent value to cover indirect expenses will be less.

All such variations must receive the attention of works management to suit varying working conditions: but the principle involved is the same for all.

It is quite possible for material value to be low and wages high, then the per cent value on wages to cover indirect expenses will be low also, supposing these to be invariable. On the other hand, material value may be high and wages low, then the percentage on wages to cover indirect expenses will be high. At this stage an explanation is necessary or the reader may be led into error. Whatever the working capital may be everything must be paid out of it. And if the £50,000 mentioned is turned over four times in the year, at the end of each quarter it is returned in the money received from invoiced goods.

Where the whole working capital is used, and that may be turned over four times in the year, which is equivalent to using £200,000 in one year, the addition to cover depreciation, profit, bad debts, etc., must be obtained by an overdraft from the bank on which interest is charged: besides there may be loan expenses and others that are contingent to business generally and all must be provided for.

The variations that occur in various works in regard to proportions never alter the fact that a big wages bill should mean a relatively low indirect expenses account and vice versa.

This appears to be contrary to some practice, but in reality it is not so, though it is true that small

work entails a higher percentage than large work, and this needs examining to remove what appears to be an apparent error in the deductions arrived at. As a fact, the indirect expenses are lower on large work than on small, therefore they vary also; but the sum of wages and indirect expenses plus material must always measure out the value of the working capital whether the work done is large or small; hence, though the relative proportions alter, the total must remain constant.

Under the conditions laid down all profit is eliminated from the proportions taken; therefore, material, wages, and indirect expenses must each be saddled with whatever profit is sought for. Therefore, material plus wages is the real value on which a percentage for indirect expenses must be laid. This is sound in every way if the material value is traced back to its source direct, because material only gets value in proportion to the labour expended upon it, and initially the ore has no value, but its getting and the endless variety of operations it passes through before it becomes a useful commodity is due entirely to the labour expended upon it; hence material value is really wages, and this value plus actual wages, as understood, makes up the sum to which the indirect expenses are referred, because these expenses are incidental to the manufacture of the finished article from the crude ore.

The nature and character of a manufactured article has an influence on indirect expenses; therefore, though the underlying principle is always the same, contingent factors alter, and this variation is the cause of high or low indirect expenses. It is easy

to see this, because a working capital is that from which profits are derived, and from it must be paid every item of expenditure entailed in production.

Another matter must be borne in mind, viz. as the price of a large piece bears a value due to the work expended on it, so a small piece may be of much more value per unit weight, because more work has been expended on it; in fact, the small piece may be of equal value to the very much larger one. Thus where a big proportion of a working capital is used up in material the wages proportion is small, but the indirect expenses are small in proportion; therefore large work supposes a low percentage, and small work a large, and the apparent error disappears.

Pursuing the investigation on different lines, suppose an engineering works, well established, is at work on an average output, and paying £750 per week for fifty weeks = £37,500 per annum, and suppose the working capital is used twice in the year, then £18,750 is absorbed by wages. Suppose 212 per cent of £18,750 is sufficient to cover all indirect expenses, but referred to the assumed annual value 106 per cent is enough. Now 106 per cent of £37,500 = £39,750 ÷ 106 = £375, and

Management	entails	6	shares = £375 × 6	= £2250
Drawing Office	,,	8	,, = 375 × 8	= 3000
General Office	,,	8	,, = 375 × 8	= 3000
Secretary	,,	3	,, = 375 × 3	= 1125
Watchman, etc.	,,	2	,, = 375 × 2	= 750
Power, Light, and Heat	,,	7½	,, = 375 × 7½	= 2812
Repairs and Renewals	,,	22	,, = 375 × 22	= 8250
Staff Salaries	,,	23	,, = 375 × 23	= 8625

Rates, Taxes, and Water	entails	4	shares	= £375 × 4	= £1500
Insurance	,,	1	,,	= 375 × 1	= 375
Petty Cash, etc.	,,	9	,,	= 375 × 9	= 3015
Advertisements	,,	6	,,	= 375 × 6	= 2250
Stationery	,,	3	,,	= 375 × 3	= 1125
Travelling, etc.	,,	2	,,	= 375 × 2	= 750
Incidentals	,,	$1\frac{1}{2}$	,,	= 375 × $1\frac{1}{2}$	= 562

equal to practically the 106 per cent on wages. Of course this is additional to the actual capital involved which must be kept intact.

The yearly wages value equal £37,500, added to £39,750, for indirect expenses, giving £77,250, and as 30 per cent of the working capital yearly value is assumed to be the value of the material, then $77{,}250\frac{100}{70} = £110{,}214$ per annum, but for a working capital turned over twice in the year, only £55,107 is required.

It has been assumed that the working capital per annum is equal to £110,214, but an equal amount is said to be sunk in plant, and another equal amount in buildings, plus £12,000 sunk in land, making an assumed capital investment of £342,642 on which $2\frac{1}{2}$ per cent bank interest must be paid, and say $7\frac{1}{2}$ per cent profit—though another 5 per cent is absorbed by bad debts, etc., making a total of £51,395, to be earned by using £55,107 working capital, turned over twice in the year—though the yearly putative capital is £110,214 which must carry about 46·6 per cent to cover the items mentioned. But this only means a turnover of £161,609. Depreciation of plant may average $12\frac{1}{2}$ per cent and buildings 5 per cent: besides consideration must be given to the possibility

of having to remove the works: therefore these may involve another £40,000, assuming that appreciation ie equal to depreciation. Thus the yearly turnover will be equal to £201,609, but to meet every contingency call it £250,000: thus, a safe basis is reached when the required turnover is assumed to be equal to 73 per cent of the invested capital to ensure a profit of 7½ per cent outside of the 2½ per cent bank interest, usually allowed.

Thus a sure and simple method is proposed to guard against any mistaken idea in regard to the proportion that the turnover value should bear to the invested capital.

Many things may appear complicated, yet very little consideration will make the fact clear that if a sovereign is used in business, unless it returns more no profit is made, and if less the loss is increased because 2½ per cent is available at any bank.

The sovereign may be the result of a manifold number of borrowings from one to the other to oblige the one who uses it; but nothing can alter the fact that only a sovereign is in question.

If every one who handles the sovereign requires payment for his trouble the charges total up to a large amount, probably to more than the value of the money used, and before it reaches the original holder's hands it may be appreciated to two and a half times the value. But the original holder started with a sovereign and wants a sovereign back plus 10 per cent interest for its use and so on to the last to use it; therefore the profit is on the invoice value.

Very rarely does the working capital cover the year's disbursements, because either by actual repayments or draws on account capital is turned over more than once in a year.

Whatever complications occur in business one aim is before the eyes of the proprietor—to preserve the capital intact whilst winning a profit beyond what a banker would allow, and the sovereign mentioned is indicative of what occurs with larger sums invested.

Engineering finance glamours the uninitiated, and tends to frighten the would-be organizer who desires to bring order out of what appears to be intolerable chaos.

The examples worked through are merely approximations, but they are based on ground principles that are sound in every sense.

In this connexion nothing has been said of stock, but this has been done designedly on the supposition that stock varies little; but where stocks are increased or decreased the difference should be noted, either to appreciate or depreciate the total invoice value.

Stock must be kept, though an efficient organizer will keep it low but ample. As an indication, stock may equal from 20 to 30 per cent of the assumed invoice value, and purchases may be about the same, or more.

Perhaps the preceding setting out is not sufficiently clear to the reader's mind; therefore something more like a sight-view will be introduced, although it must only be approximate owing to the natural variations of manufacturing businesses.

Thus it is but an object lesson to show somewhat the nature and trend of things the organizer has to tackle rather than an attempt to show him the way by fair examples.

It must be obvious to all that this work is written for those who have already got beyond the mere fringe of works management, otherwise it will be no more than a dead language to them. Ability to use means to a good end is assumed to exist, or otherwise little advantage will be gained by reading a book of this character. A machine may cost much money and be capable of doing much work, but it requires a skilled operator to get the best out of it. Using a 20-inch centre lathe to carry a 6-inch emery buff on a mandril is not what a competent man would do; therefore if any reader has not got beyond that stage of knowledge, he will find considerable difficulty in following the more intricate problems of works management.

Many matters beyond those mentioned deserve to receive attention, but space prevents more than a mere reference. For instance, reserve funds are important, especially when it has to do with firms acting under the public Companies Acts. Such funds are particularly advantageous to the organizer, and a little attention must be given to this matter at a subsequent period.

Every business is conducted on the principle of profit and loss, and all look for a balance on the right side; otherwise little encouragement is given to continue in a course of such a hazardous nature as manufacturing.

CHAPTER XVI.

SOME PLAIN UNVARNISHED FACTS.

A POUND weight placed in the scale-pan of a pair of scales should balance an equal weight on the other side. It is not necessary that one pan should hold exactly as much as another in regard to bulk or number, but the aggregate weight should balance. In any works a number of details represent a given monetary value, and it matters not how the value is made up it represents expenditure, and the total value is the amount owing to the works which must be balanced by the other side as income. Profit and loss accounts are based on this principle, and such accounts furnish a sight-view of how the balance is affected; for example:—

PROFIT AND LOSS ACCOUNT.

FOR THE YEAR ENDING .

To stock previous year .	£20,000	By sales . . .	£56,584
,, purchases . . .	14,573	,, addition to building	988
,, salaries . . .	15,930	,, ,, to plant .	3,269
,, wages . . .	15,559		
,, repairs and renewals .	8,496		
,, rates, taxes, and water	1,416		
,, power, light, and heat	2,655	,, works in progress .	25,000
,, insurance . . .	354		
,, petty cash . . .	3,186		
,, advertisements . .	2,124		
,, stationery . . .	1,062		
,, travelling, etc. . .	1,231	,, stock at end of year .	20,000
,, interest, gross . .	15,000		
,, depreciation, building	988		
,, ,, plant and tools	3,267		
Total .	£105,841	Total . .	£105,841

As one side balances the other there is evidence of good organizing, because the whole profit has been earned, or £15,000 shows as expenditure on one side and is recovered as income on the other.

Funded Reserves.—Whether it is a private firm or a public company reserves are necessary. It is not always convenient nor expedient at the close of the financial year to increase the buildings or add to plant, tools, etc., therefore the funds derived from the depreciation as taken out of revenue are banked to a separate account. For a private firm one account is all that is needed, but for a public company a single fund might easily be depleted, if it is merely a company's reserve, to make up the surplus for a bad year's dividend.

By keeping a building fund account and a plant account reserve separate from the ordinary reserve fund, the value is available for the purpose intended and for no other.

The addition of new plant frequently opens out new markets, and contracts can be catered for on usual lines, which would be impossible if cost of plant to produce was added to the estimate. It matters not if the capital is merged in plant or held by the bank, its interest of 2½ per cent is presumedly assured. The same reasoning applies to additional buildings.

To increase the trading capabilities of a firm is the aim of every organizer, because it means increased production at a greater profit, and additions to buildings and plant allow the firm to compete against firms who have hitherto been looked upon as specialists.

By keeping capital value up to its original figure by

allowing depreciation to become appreciation we obtain a distinct advantage, because volume of trade is extended and, relatively, indirect charges are reduced, and an increased profit is the result.

Recapitulation.—Works management must deal with the principles of organization, and it is impossible to sever the works from the commercial part, because management begins with the inception and finishes with the final delivery of a production. This does not mean that the organizer has the direction of the commerical staff, but it does assume that he is the advisor, and where the indirect expenses of the commercial side of the business become a handicap to production at the market price, the organizer is the man responsible, and his authority must be paramount in regard to the per cent value of the expense entailed though not as to the method when operated within the prescribed limit.

Works management cannot but be the guiding power in all production, even in regard to those things some think to be outside of its province. It is only reasonable to assert that works management merely confined to what may be called the practical side might organize in a way that a large margin of profit is available, and still the producing power would not bring a satisfactory result if the commercial side eats up all the advantage gained by bad practices that involve excessive expenditure and a final loss. Directly such a case becomes evident the remedy naturally falls into the works manager's hands, and his authority must be supreme.

The debatable question of writing off repairs and renewals instead of adding it to the valuation account

is important, because works management has to do with capital invested in the works, and not that held by the bank. To wipe out an amount that adds value to the capital sunk is placing the manager in the unenvious position of really having what he cannot claim. True, the valuation taken every seven years will reinstate the over-depreciated value, but the in-between years are saddled with a disability that is unnecessary.

The case is nearly analogous to a method adopted by some firms, who, to suit their own purposes, or through ignorance, reckon an interest of 5 per cent on the yearly outlay as too little, whereas they may use their capital four times, and the actual profit is 20 per cent. This is unfair to an organizer and makes for him a serious difficulty when estimating against firms who base their yearly profits on the actual capital used and not on the putative expenditure in one year.

On the other side of the question, where repairs and renewals are wiped out from revenue, it is certain that the plant is improved and its output is increased, giving the idea that a better result is reached on a lower capital value, and under this impression prices may be reduced, and only when the actual truth is ascertained will the foolishness of the expedient be seen, and then too late to change a rate that means really a reduction of profit, because more capital value is sunk than that accounted for.

Another class of depreciation requires some attention, namely where new machines are introduced to increase production, and the percentage allowed for depreciation is measured by the relative output and

not by the true ratio of loss occasioned by increased wear and tear which is much beyond what the relative productions measure.

In a few years' time fast-producing plants will be worn out and with little money in hand to reinstate them. Already the pinch has begun to be felt, and a wail came from over the Atlantic a year or two ago in regard to this very matter. Machines were worn out and prices of product had gone down enormously, whilst the depreciation was totally inadequate to account for the rapid decay.

Another thing seems to be forgotten with fast-production machines; their production is good, and owing to the volume turned out prices are accordingly reduced, yet the losses, when such machines stand, are enormous; therefore, too little depreciation and loss due to standing in time begins to tell a tale, which in the end means a serious loss.

High speeds and quick feeds demand more than a mere addition of power in proportion to production, and these are not always considered; therefore, works management must be alive to every variation to measure it at its true value.

Another thing works management needs to attend to. Under special conditions a vast volume of trade occurs, much beyond what the average entails, and to meet it works are enormously increased and plant considerably added to, all entailing a number of extra indirect charges. When the phenomenal time passes and the usual come and go state returns, manufacturing small quantities in big works carrying heavy expenses makes the outlook bad. Works management under proper organization always has

an eye on the average and not on phenomenal movement, and in cases of excessive pressure the cost is counted and others are employed to help with the excess—probably at some present loss but eventual gain, when average conditions begin to rule.

Works management should constantly gather together information, and frequent testing of per cent values will lead to sure reduction without destruction to excellence or lowering of profit; and this is especially true in regard to works costs.

If the truth was known, probably one-third of the whole capital in the country rarely makes a profit and possibly makes a frequent loss. Many big companies are so overloaded with that curse to all businesses, a heavy good-will, which becomes a sort of convenience to balance up poor balance sheets, that all good management should gradually wipe out and not add to it.

A case in point is a very large concern whose capital was depleted by 75 per cent, involving the loss of a fabulous sum of money, and many others are probably in as bad a condition which time will reveal.

Works management is what is wanted to increase the value of production at a reduced cost, and few will deny the fact that bad organization is at the root of much of the trade difficulties that depreciate our value in the markets of the world and puts us out of competition with other manufacturing nations.

Something must be said of twentieth-century methods, because volume of ingenuity is restricted, and the cause seems to be in the fact that there is too much reliance on what others have done in the

past and not enough trust in our own ability to better conditions which other nations show us can be done.

In this work principles lead the way, and the causes that produce effects are considered more valuable than the results attained by what custom teaches and convention circumscribes.

The basis of all true organizing is to do what is right and not what is popular, though much of the popularity is born of an ignorance that is pitiable; it makes it more incumbent on the works management to take pains and get better things.

Piece work versus day work could be made the subject-matter of many books of this character; yet the end of it would be a return to the question of good organizing and works management, because that is the key to a profitable industry of a sure and durable character.

Neither one or the other are preferred, because each in its place may be suited to conditional factors.

As a final recapitulation the qualifications required of a man to meet the difficult task of works management are worth recording.

He need not be a specialist in any sense of the word, though he must be a man with abundant knowledge, and possessed of a firm reliance on self, which others accept and appreciate. His tact and judgment permits him to see that he knows less than his departmental officers; yet he is confident, and this will give confidence to others by a wide and useful knowledge he possesses being governed by first principles rather than by actual education.

Other officers may be more capable than he is in some speciality, but as a general practitioner, either actually or by instinct, his judgment is rarely astray, and in time of difficulty he is a tower of strength even to the specialist.

INDEX.

M.

O.

P.

R.

S.

T.

U.

V.

W.

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